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EPIDEMIOLOGIC INVESTIGATION
OF
THIRD NATIONAL CANCER SURVEY DATA
FOR
ST.LOUIS PARK, EDINA, RICHFIELD, AND
THE MINNEAPOLIS-ST. PAUL
STANDARD METROPOLITAN STATISTICAL AREA
WITH A HISTORICAL REVIEW
OF
ST. LOUIS PARK'S WATER SUPPLY

By

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PREFACE

This paper is the product of my Plan B Project/Field Experience in epidemiology (in fulfillment of PubH 8-331, 8 credits) obtained from the Minnesota Department of Health. The work was begun in March, 1979 and was done under the direction of Dr. Andrew Dean and Eunice Sigurdson. Its purpose was to use Third National Cancer Survey data to evaluate the significance of any differences in cancer incidence in St.Louis Park compared with Edina, Richfield, and the Minneapolis - St.Paul Standard Metropolitan Statistical Area.

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I. Materials and Methods

A. SOURCE OF DATA

Third National Cancer Survey data represent newly diagnosed primary cases of cancer ascertained during the three year period, 1969 to 1971, among residents of seven SMSAs* and two entire states. This survey is the third (first 1937-1939, second 1947-1949) in thirty years conducted by the National Cancer Institute. Cases of cancer are distributed by 45 sites and by age, sex and race. Benign tumors, skin cancers, carcinomas in situ and tumors unspecified as to malignancy are not included.

Methods

Data was collected from three types of sources:

1. reports from physicians,
2. reports from in-patient and out-patient hospital departments, clinics, pathology laboratories and radiotherapy facilities
3. information from death certificates mentioning cancer.

For the entire TNCS, medical records provided the information in 97.9% of the cases.

An example of the hospital and clinic abstract form used for the TNCS is included (Table 1-1).The form is divided into three sections. Section I is entitled "Patient Information" and includes name of patient, address of patient at time of diagnosis, as well as the sex, race, marital status, age at admission, date and place of birth, social security number and hospital history number of patient. Section II is entitled "Hospital and Medical Information" and includes date of first diagnosis, date of admission, date of discharge, referral source, primary site, histologic type, method of diagnosis, information on other independent cancers, and name of hospital. Section III is entitled "Survey Information" and includes sources checked, date of abstract and abstractor ID.

Tumor type and site are coded according to The Manual of Tumor Nomenclature and Coding (1968, American Cancer Society). One of the special features of this survey is the detailed classification of histologic information.

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Results

Some major findings of the TNCS include the following:

1. Men have more cancer than women. Black males > white males > white females > black females.
2. Regional variation is decreasing, except for skin cancer.
3. The most frequent site of cancer is the colon and rectum.
4. 75% of all cancers occur in only 10 anatomic sites - large intestine (14.7%), breast (13.6%), lung (13.3%), prostate (8.2%), uterus (7.2%), lymphoma (4.5%), bladder (4.3%), stomach (3.5%), leukemia (3.3%), and pancreas (3.2%).
5. Cancers which attack only women occur earlier in life than do those which attack only men.
6. The age pattern of cancer incidence differs in the two sexes. For ages less than 25, the rate is low among both males and females. For ages 25-55 the incidence increases more rapidly among females than males. From age 55 on, the increase is much more rapid in men so that at 80-84 the rate is almost two times as great in males.

Comments

Information collected on the 5 county Minneapolis - St. Paul SMSA (Hennepin, Ramsey, Washington, Dakota and Anoka counties) as one of the nine geographic areas surveyed in the TNCS, is stored on computer tapes. Incidence data for residents of St. Louis Park, Richfield and Edina were abstracted from these computer tapes identified by census tract. These data are the basis for the calculation of incidence rates and other statistics for the St. Louis Park Creosote Study.

E. WHY MORBIDITY DATA INSTEAD OF MORTALITY DATA

Three cancer indices can be used to evaluate the magnitude of the cancer problem: mortality, incidence and prevalence.

Mortality data are usually more readily available and for certain cancers with poor prognosis, mortality rates closely approximate incidence rates. Incidence rates, however, are more sensitive indices in regard to the effects of and changes in environmental exposure. Because of the nature of the problem to be studied and the availability of good incidence data, albeit for a short period of time, 1969 to 1971, we decided to do a statistical-epidemiologic study of cancer incidence.

Incidence data is superior for another reason; that is, that morbidity has three possible courses: continuation, recovery, or death. In studying the magnitude of the cancer problem, not only those who die from the disease, but also those who survive it are of interest.

Furthermore, mortality data comes from death certificates which are completed with little quality control over their medical accuracy and consequently are often inaccurate regarding cause of death. Death certificates also do not provide sufficient detail on the histology or the specific anatomic site of tumors to permit study of various cancers.

Table 1-1. Third National Cancer Survey Hospital and Clinic Abstract Form

Budget Bureau No. [illegible] Approval expires 12-31-72

THIRD NATIONAL CANCER SURVEY

HOSPITAL AND CLINIC ABSTRACT

1. DOCUMENT IDENTIFICATION NUMBER (Area, [illegible], Year, [illegible], Doc. Number)

2. CASE NUMBER

SECTION I - PATIENT INFORMATION

3. LAST | 4. FIRST | 5. MIDDLE (Maiden) | 6. SPOUSE'S FIRST NAME

HOUSE NO. | 8. STREET NAME OR NUMBER | 9. APT NO. | 10. TOWN OR CITY | 11. STATE

ZIP CODE | 13. COUNTY | 14. If patient's usual address is a hospital, nursing home, hotel, etc., give NAME | NAME OF INSTITUTION

Date of Birth (Month, Day, Year)

Age at Admission

Sex: Male C 2-Female C 3-Unknown

Present Marital Status: Married, Widowed, Separated, C 4-Divorced, C 5-Single (Never married), C 6-Unknown

19. Race: C 1-Caucasian, C 2-Negro, C 3-Chinese, C 4-Japanese, C 5-American Indian, C 6-Other (Specify), C 7-Unknown

20. Birthplace (State or country)

21. Social Security Number

22. Hospital History Number

SECTION II - HOSPITAL AND MEDICAL INFORMATION

Was this the first admission to this hospital for this cancer? Yes C 2-No C 3-Unknown

Was this cancer diagnosed before this admission? Yes C 2-No C 3-Unknown

If "Yes", please specify:

NAME (Doct. or Inst.)

ADDRESS

CITY STATE

Date of first diagnosis of this cancer (Month, Day, Year)

Date of this admission

Date of discharge

Referral Source: Doctor*, Other hospital*, Nursing home*, Self, C 5-Statutory authority, C 6-Other*, C 7-Unknown

If "1, 2, 3, or 6 above", please specify:

NAME (Doct. or inst.)

ADDRESS

CITY STATE

Primary site AT THIS CONTACT

Histologic type AT THIS CONTACT

33. Method of Diagnosis

MICROSCOPICALLY CONFIRMED: C 1-Autopsy, O 2-Tissue from primary site under direct or indirect vision, C 3-Blind biopsy or tissue not from primary site, C 4-Cytology or Hematology, C 0-Micro, tissue source or method not known

NOT MICROSCOPICALLY CONFIRMED: C 5-Gross Specimen only, C 6-X-Ray, C 7-Clinical, C 8-Other (specify), C 9-Unknown

34. How many other independent cancers has this patient ever had? C 0-None, C 1-One, C 2-Two, C 3-Three or more, C 4-An unknown number, C 5-Don't know

For most recent ind. cancer, please specify:

35. PRIMARY SITE

36. HISTOLOGIC TYPE

37. DATE OF DIAGNOSIS (Month, Year)

NOTE: For any additional independent cancers, specify in the Comments section below, primary site, histologic type, and month and year of diagnosis.

38. Follow-up after discharge by: C 1-Doctor*, C 2-Hospital*, C 3-Nursing home*, C 4-None, C 5-Died in hospital (Give cause), C 6-Other*, C 7-Unknown

39. *If "1, 2, 3, or 6 above", please specify:

NAME (Doct. or Inst.)

ADDRESS

CITY STATE

40. NAME OF HOSPITAL

COMMENTS: Refer to Question No. when making comments

SECTION III - SURVEY INFORMATION

SOURCES CHECKED: Discharge summary, Progress notes, Pathology report, Discharge diagnosis, Operative notes, [illegible]

DATE OF ABSTRACT

41. ABSTRACTOR ID

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42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53. 54. 55. 56.

C. SOCIAL AND ECONOMIC CHARACTERISTICS OF COMPARISONS AREAS (Table 1-2)

Edina, Richfield and the Minneapolis - St.Paul SMSA were selected as comparisons. Richfield was selected because it was a SMSA suburb similar to St. Louis Park in social and economic characteristics such as median school years completed, percent high school graduates, occupation and median and mean family income. Edina was selected because the contamination was believed to be moving in that direction. The entire SMSA was used as the major comparison area, its larger numbers lending greater stability to calculated rates.

As stated, in 1970 Richfield compared favorably with St.Louis Park for the selected indicators of socioeconomic status namely income, education and occupation. Edina, however, was seen to be more affluent according to indicators of mean and median income, median school years completed, percent high school graduates and percentage of its labor force employed as professional, technical and kindred workers or as managers and administrators. The SMSA compared favorably with St. Louis Park for mean and median income as well as median school years completed. For occupation, however, it did not compare so favorably with St.Louis Park. The SMSA had substantially smaller proportions of its labor force employed as managers and administrators or in retail or wholesale trade with substantially larger proportions employed as craftsmen, foremen and kindred workers or in manufacturing. Furthermore, the SMSA had a greater percentage of families with incomes below poverty level.

For associations based on group characteristics matching comparison communities on socioeconomic indicators is desirable because there are certain components within social class that lead to disease, such as medical care (specific therapy), diet, and working conditions (occupational exposures). It is therefore important to note the aforementioned differences between St.Louis Park and the three comparison areas.

Table 1-2. Social and Economic Characteristics of Comparison Areas

	EDINA	RICHFIELD	ST. LOUIS PARK	MSP SMSA*
I. Median school years completed, person ≥ 25	14.3	12.6	12.6	12.4
% high school graduates, persons ≥ 25	88.7	78.1	75.8	66.1
II. % males ≥ 16 in civilian labor force, unemployed	2.0	2.1	1.9	3.1
Total employed, ≥ 16	17,114	23,345	23,165	759,606
% professional, technical, and kindred workers	26.0	18.8	20.1	18.4
% managers & administrators	25.8	10.1	11.8	8.9
% craftsmen, foremen, and kindred workers	4.1	11.8	10.2	12.4
% laborers, except farm	2.0	2.7	2.7	3.8
% construction	3.5	5.4	4.2	5.4
% manufacturing	19.0	20.0	20.6	24.7
% transportation	2.4	6.5	11.9	4.9
% wholesale trade	10.6	7.4	10.6	6.3
% retail trade	18.4	21.1	22.3	16.7
III. Median family income	19,494	12,504	12,483	11,682
Mean family income	23,417	13,132	14,203	13,147
% families with social security	14.7	11.2	15.7	16.2
% families with income below poverty level	1.6	1.8	2.3	4.6

* Minneapolis-St. Paul Standard Metropolitan Statistical Area

Source: 1970 Census of Population and Housing, Minneapolis-St. Paul Standard Metropolitan Statistical Area, Minnesota, PHC(1)-132, March, 1972.

I. Table P-2. Social Characteristics of the Population: 1970. p. P-37, P-38.

II. Table P-3. Labor Force Characteristics of the Population: 1970. pp. P-73, P-74.

III. Table P-4. Income Characteristics of the Population: 1970. pp. P-109, P-110.

D. COMPUTER SPECIFICATIONS AND ANALYTICAL METHODS

Abstracts of cancer records for the Minneapolis-St. Paul component of the Third National Cancer Survey were coded and stored on computer tape. Records on all white residents of Edina, Richfield, and St. Louis Park that had a cancer diagnosed during 1969, 1970, or 1971 were selected. Analysis was restricted to whites only because the non-white component of each area was less than 3%. Each city was defined by an aggregation of census tracts as shown in Table 1-6.

The computer specifications I created looked at 45 sites of cancer as well as organ system totals by age, sex and city. Incidence rates were age-adjusted to the SMSA populations of white males and white females respectively. Calculations were done of average annual age- and sex- specific cancer incidence rates, age-adjusted cancer incidence rates, standard incidence ratios, Mantel-Haenszel overall summary chi-square and z statistics. (Tables 1-3, 1-4 and 1-5) The latter two statistics were used to assess the significance of the difference between two rates after adjusting for age. (See Appendix A for discussion on use of the Mantel-Haenszel statistic and the z statistic). Population denominator data displayed in Table 1-7 were taken from the 1970 U.S. Census.

In addition to the statistical analyses performed, a listing of addresses in ascending order by census tract, site and case number was created.

Table 1-3, Computer Specifications and Analytical Methods

1. Arrange sites by organ system using the site or site and histology codes given. (see Table 1-5).

2. TABLES WITH 3 YEAR TOTAL NUMBER OF CASES 1969-1971.

   By sex for each city, make a separate table with the total number of cases per age interval and for all ages for each individual site of cancer, for each organ system and for all sites of cancer combined.

3. TABLES WITH AVERAGE ANNUAL INCIDENCE RATES/100,000 1969-1971.

   By sex for each city, make a separate table of average annual age and sex-specific incidence rates per 100,000 population for each individual site of cancer, for each organ system and for all sites of cancer combined.

4. TABLES WITH AVERAGE ANNUAL AGE - ADJUSTED INCIDENCE RATES/100,000 1969-1971.

   By sex for each city, make a separate table of average annual age-adjusted rates per 100,000 population for each individual site of cancer, for each organ system and for all sites of cancer combined. Use the direct method of adjustment: apply the average annual age and sex-specific incidence rates per 100,000 of study population to the respective proportions of the population in that age and sex group in the standard population (Mpls. - St. Paul SMSA).

   Eg. $\sum_{i=1}^{9} \frac{riPi}{P} = \sum_{i=1}^{9} \left(\frac{Pi}{P}\right) ri$

5. STANDARD INCIDENCE RATIO (SIR) CALCULATION

   By sex for each city, multiply the number of persons within each age group of the study population by their respective average annual age and sex-specific incidence rates per 100,000 of the standard population (Mpls. - St. Paul SMSA), then sum and divide by 100,000 to obtain the expected number of cases per year. Calculate SIR =

   $$\frac{\text{observed \# of cases per year}}{\text{expected \# of cases per year}}$$

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   For each individual site of cancer, for each organ system and for all sites of cancer combined.

6. Z STATISTIC CALCULATION

Change all 3 year case numbers that are zero to .5 (½ of a person). Then by sex for each comparison (SLP-E, SLP-R, E-R), calculate a Z statistic using 3 year age-adjusted rates. We will use a standard normal table to interpret these results. (See Appendix A for Table).

$$Z = \frac{\left| \text{adjusted rate 1} - \text{adjusted rate 2} \right|}{\sqrt{\text{variance (adj. rate 1)} + \text{variance (adj. rate 2)}}}$$

where the variance (adj. rate) $= \sum_{i=1}^{9} \left(\frac{P_i}{P}\right)^2 \left(\frac{r_i \ (1-r_i)}{n_i}\right)$

where r = age and sex specific rate and n = denominator of r.

7. MANTEL - HAENSZEL SUMMARY CHI - SQUARE CALCULATION

Use the Mantel-Haenszel method to calculate overall summary chi-square for the six comparisons given (SLP-E, SLP-R, SLP-SMSA, E-R, E-SMSA, R-SMSA). This method should be executed on the total number of cases for the 3 year period. Indicate with an asterisk any values significant at the 5% level. See Table 1-4 for Method.

8. Print the following information on St. Louis Park cases, arranged by census tract:

   a. address
   b. age at diagnosis
   c. sex
   d. case number
   e. date of first diagnosis
   f. primary site and histologic type
   g. method of diagnosis

Table 1-4. Calculation of the Mantel-Haenszel Overall Summary Chi-Square Statistic

Calculate an overall summary chi-square for the following comparisons:

1. St. Louis Park vs. Edina
2. St. Louis Park vs. Richfield
3. St. Louis Park vs. SMSA
4. Edina vs. Richfield
5. Edina vs. SMSA
6. Richfield vs. SMSA

Mantel-Haenszel Method *

1. Given i = age interval, i = 1,9; j = sex, j = 1,2; k = city, k = 1,4

i	j	k
i = 1 = < 15	j = 1 = male	k = 1 = St. Louis Park
2 = 15-24	2 = female	2 = Edina
3 = 25-34		3 = Richfield
4 = 35-44		4 = Mpls-St. Paul SMSA
5 = 45-54		
6 = 55-64		
7 = 65-74		
8 = 75-84		
9 = 85+		

2. By sex for each city determine the total # cases, 1969-1971, per age interval, n_{ijk}.
3. By sex for each city determine the population per age interval, p_{ijk}.
4. By sex for the two comparison cities determine their combined # cases per age interval, $N_{ij} = n_{ijk} + n_{ijk'}$
5. By sex for the two comparison cities determine their combined population total per age interval, $P_{ij} = p_{ijk} + p_{ijk'}$.
6. By sex for the two comparison cities determine their mean incidence rate for each age interval, $R_{ij} = \frac{N_{ij}}{P_{ij}}$.
7. By sex determine the expected # cases per age interval for <u>one</u> of the two comparison cities, $E_{ijk} = R_{ij}p_{ijk}$.
8. By sex determine the observed # cases per age interval for the same city, $O_{ijk} = n_{ijk}$.

9. By sex determine the variance of the observed# cases minus the expected # cases for each age interval,

$$V(O_{ijk}-E_{ijk}) = \frac{(p_{ijk})\ (p_{ijk}')\ (N_{ij})\ (P_{ij}-N_{ij})}{(P_{ij})2\ \ (P_{ij}-1)}$$

10. By sex for the two comparison cities calculate an overall summary chi-square, $X^2(1) - \frac{[\ |\sum_i O_{ijk} - \sum_i E_{ijk}| - .5]^2}{\sum_i V(O_{ijk}-E_{ijk})}$

11. Evaluate the chi-square value thus obtained and if the value is $>$ 3.84, use an asterisk to indicate that it is significant at the 5% level.

12. Calculate an overall summary chi-square for the comparison of two age- and sex-adjusted rates,

$$X^2(1) = \frac{[\,|(\sum_i O_m + \sum_i O_f) - (\sum_i E_m + \sum_i E_f)\,| - .5]^2}{\sum_i V(O-E)_m + \sum_i V(O-E)_f}$$

13. Evaluate the chi-square value thus obtained and if the value is $>$ 3.84, use an asterisk to indicate that it is significant at the 5% level.

14. Repeat this procedure for each of the six comparisons specified.

* Apply this method to individual sites of cancer, organ systems, and to all sites combined.

Table 1-5. Site or Histology Code * with Assigned Computer Code

		Site Code	Computer Code
I.	Buccal Cavity and Pharynx	400-490	4
	lip	400-409	40
	tongue	410-419	41
	salivary gland	420-429	42
	gum and mouth	430-459	43-45
	nasopharynx, other pharynx and tonsil	471-479,461-469, and 480-489	46-49
II.	Digestive System	500-584 not 588-589	5
	esophagus	500-509	50
	stomach	510-519	51
	small intestine	520-529	52
	colon, exc. rectum	531-539,544	53
	rectum and rectosigmoid jct.	540-541	54
	liver	550	55
	gallbladder	560	11
	other biliary	551,561-569	56
	pancreas	570-579	57
III.	Respiratory System	600-624	6
	larynx	610-619	61
	lung, bronchus, trachea	620-624	62
IV.	Bones and Joints	700-709	70
V.	Soft Tissues	710-719	71
VI.	Melanomas of Skin	730-739 (types 8721-8783)	73
VII.	Breast	740-749	74
VIII.	Female Genital System		800i
	cervix invasive	800-809	80
	corpus uteri	820	12
	uterus, NOS	829	82
	ovary	830	83
	vagina	840	13
	vulva	842-843	84

* Site and histology codes from the Manual of Tumor Nomenclature and Coding, 1968 Edition.

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Table 1-5 Continued

		Site Code	Computer Code
IX.	Male Genital System		8002
	prostate	859	85
	testis	869	86
	penis	870	87
X.	Urinary System	889-898 not 899	8003
	bladder	889	88
	kidney and renal pelvis	890-891	89
XI.	Eye and Orbit	900-909	90
XII.	Brain and Other Nervous System		9001
	brain	910-919 not 9531-9533	91
	other nervous system	920-929	92
XIII.	Endocrine System	930-940	9002
	thyroid	930-931	93
	other endocrine system	---	---

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The MOTNAC site codes for the following are 960-969, nodes.

		Histology Code	Computer Code
XIV.	Lympho & Reticulum Cell Sarcoma	9611-9643	14
	lymphosarcoma, NOS	9613	141
	lymphocytic lymphosarcoma	9623	142
	lymphoblastic lymphosarcoma	9633	143
	reticulum cell sarcoma, NOS	9643	144
XV.	Hodgkin's Disease	9653-9683	15
	hodgkin's disease, NOS	9653	151
	hodgkin's disease, lum.-his.predominance	9654	152
	hodgkin's disease, mixed cellularity	9655	153
	hodgkin's disease, lym. depletion	9657	154
	hodgkin's disease, nodular sclerosis	9658	155
	hodgkin's paragranuloma	9663	156
	hodgkin's granuloma	9673	157
	hodgkin's sarcoma	9683	158
XVI.	Other Lymphomas	9591-9603,9691-9693, 9711-9723,9741-9763	16
	lymphoma, NOS	9593	161
	stem cell lymphoma (no cases)	9603	162
	giant follicle lymphoma	9693	163
	Burkitt's tumor (no cases)	9753	164
	lymphosarcoma ending in leukemia	9763	165

The MOTNAC site code for the following is 698, RES.

		Histology Code	Computer Code
	reticuloendothelial sarcoma	9723	166
	microglioma (no cases)	9713	167
	mast cell sarcoma	9741-9743	168

The MOTNAC site codes for the following are 730-739, skin.

		Histology Code	Computer Code
XVII.	Mycosis Fungoides	9703	17(171)

The MOTNAC site code for the following is 691.

		Histology Code	Computer Code
XVIII.	Multiple Myeloma	9731-9733	18(181)
XIX.	Leukemias	9803-9951	19
	leukemia, NOS	9803,9805,9807-09	191
	acute lymphocytic leukemia	9825	192
	chronic lymphocytic leukemia	9827	193
	other lymphocytic leukemia	9823,9828,9829	194
	acute granulocytic leukemia	9865	195
	chronic granulocytic leukemia	9867	196
	other granulocytic leukemia	9863,9868,9869	197
	monocytic leukemia	9893-9899	198

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Table 1-6 Census Tracts

City code = 1	= 2	= 3
St.Louis Park	Edina	Richfield
220	231	241
221.01	235.01	242
221.02	235.02	243
222	236	244
223.01	237	245
223.02	238.01	246
224	238.02	247
225	239	248.01
226	240.01	248.02
227	240.02	249.01
228.01		249.02
228.02		249.03
229.01		
229.02		
230		

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Table 1-7
WHITE POPULATION BY AGE AND SEX FOR THE MINNEAPOLIS-ST. PAUL
STANDARD METROPOLITAN STATISTICAL AREA, EDINA, RICHFIELD AND ST. LOUIS PARK, 1970

Age Group	MSP SMSA**			Edina		Richfield		St. Louis Park	
	Males	Females	Total	Males	Females	Males	Females	Males	Females
<15	274,078	262,807	536,885	6,619	6,291	6,658	6,254	6,567	6,297
15 - 24	148,099	172,675	320,774	3,197	3,109	4,421	5,299	3,831	4,521
25 - 34	122,056	123,065	245,121	1,925	2,325	3,488	3,431	3,465	3,634
35 - 44	95,490	96,216	191,706	2,984	3,266	2,410	2,689	2,477	2,728
45 - 54	87,076	92,051	179,127	3,244	3,306	2,992	3,238	2,933	3,261
55 - 64	62,268	72,159	134,427	1,954	2,168	1,687	1,780	2,126	2,490
65 - 74	37,391	54,722	92,113	1,010	1,260	685	933	1,124	1,562
75 - 84	19,012	32,195	51,207	407	623	293	500	472	769
85+	4,081	8,328	12,409	72	144	46	123	88	162
All Ages	849,551	914,218	1,763,769	21,412	22,492	22,680	24,247	23,083	25,424

SOURCE: 1970 Census of Population, General Population Characteristics, Minnesota, PC(1)-B25 Minn., September, 1971.

Table 24. Age by Race and Sex, for Areas and Places: 1970, p. 85;
Table 28. Age by Race and Sex, for Places of 10,000 to 50,000: 1970. pp. 104, 109, 110.

** Minneapolis-St. Paul Standard Metropolitan Statistical Area

References

1. Hakama, M. et al. (1975). Incidence, Mortality or Prevalence as Indicators of the Cancer Problem. Cancer 36:2227-2231.

2. Cutler, S.J. et al. (1974). Third National Cancer Survey--An Overview of Available Information. J. National Cancer Institute 53: 1565-1575.

3. Manual of Tumor Nomenclature and Coding.

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2. Results

For males, no cancer rates in St. Louis Park were statistically significantly different from those in the three comparison areas. It is of interest to note, however, that in view of how the Mantel-Haen el statistic works (Appendix A) that St. Louis Park males had higher crude rates across the board for ages 15-24, 25-34, 35-44 and 45-54 for all cancer sites combined. In the older age groups the opposite was true (Table 2-1 and Figure 2-1). Perhaps a cancelling phenomenon is taking place in use of this statistic. Neither the Z statistic nor the standard incidence ratio, however, indicated a significant difference between the rates of St. Louis Park and the three comparison areas.

For white males for all cancer sites combined (see Table 2-1) the crude rates increased with age in all comparison areas with one exception. The crude rate dropped in the age group 85 and older in St. Louis Park. This is the result of both a smaller number in the numerator and a larger number in the denominator. The latter is probably due to misreporting which results in considerable random flucuation in rates based on the age group 85 or older.

In Edina, Richfield and the MSP SMSA cancer overall followed the national picture for both males and females. In St. Louis Park, however, the females not only had more cancer overall in the 25-55 age group as expected, but equaled their male counterparts beyond age 55 and surpassed them in the age group 85 and older. (See Tables 2-1 and 2-2.)

For all sites of cancer combined I calculated age-adjusted rates using the total SMSA population in order to compare male and female rates.

Age-adjusted Rates / 100,000

	Male	Female
St. Louis Park	300	346
Edina	367	225
Richfield	313	216
SMSA	324	258

Note that for Edina, Richfield and the SMSA the male rate is greater than its respective female rate as expected, but for St. Louis Park the female rate is 15% greater than the male rate.

Among females, age-adjusted rates for all cancer sites combined, for breast cancer, and for cancers of the gastrointestinal tract were statistically significantly greater in St. Louis Park than in Edina, Richfield and the MSP SMSA (see Tables and Figures 2-2, 2-3 and 2-4). Breast cancer accounted for the following percentages of total number of cases: 31.6 for St. Louis Park; 37.1 for Edina; 28.3 for Richfield; and 27.6 for the MSP SMSA.

For breast cancer the standard incidence ratio for St. Louis Park was 1.48. This figure is based on 64 expected cases calculated by applying the MSP SMSA age, sex, race and site-specific rates to the white female age-specific population of St. Louis Park. This represents over the three year period 31 excess cases of breast cancer diagnosed in St. Louis Park white females. When adjusted to the MSP SMSA 1970 population of white females, the St. Louis Park rate is found to be 45% greater than the metropolitan area rate giving a high degree of statistical significance, $P<.0005$.

Table 2-1

NUMBER OF CASES, INCIDENCE RATES, AND MANTEL-HAENSZEL SUMMARY CHI-SQUARE VALUES FOR CANCERS OF ALL SITES COMBINED, WHITE MALES ONLY, 1969-1971

THREE YEAR TOTAL NUMBER OF CASES

Age Group	St. Louis Park	Edina	Richfield	MSP SMSA*
<15	2	5	2	88
15-24	3	1	0	103
25-34	4	2	3	140
35-44	15	8	3	274
45-54	34	7	24	768
55-64	46	49	31	1603
65-75	57	54	31	1988
75-84	37	50	25	1715
85+	4	10	13	450
TOTAL	202	196	132	7129

AVERAGE ANNUAL AGE-SPECIFIC INCIDENCE RATES/100,000

Age Group	St. Louis Park	Edina	Richfield	MSP SMSA*
<15	10	25	10	11
15-24	26	10	0	23
25-34	38	35	29	38
35-44	202	89	41	96
45-54	386	175	267	294
55-64	721	836	613	858
65-75	1690	1782	1509	1772
75-84	2613	4095	2844	3007
85+	1515	4630	9420	3676
TOTAL	292	303	194	280

AVERAGE ANNUAL AGE-ADJUSTED INCIDENCE RATES/100,000,**

	St. Louis Park	Edina	Richfield	MSP SMSA*
	267	296	260	280

Comparisons	CHI-SQUARE VALUES	P VALUES
St. Louis Park vs Edina	.17	>.5
St. Louis Park vs Richfield	1.23	>.25
St. Louis Park vs MSP SMSA	.18	>.5

* Minneapolis-St. Paul Standard Metropolitan Statistical Area
** Adjusted to the age distribution of the MSP SMSA population of white males, 1970.

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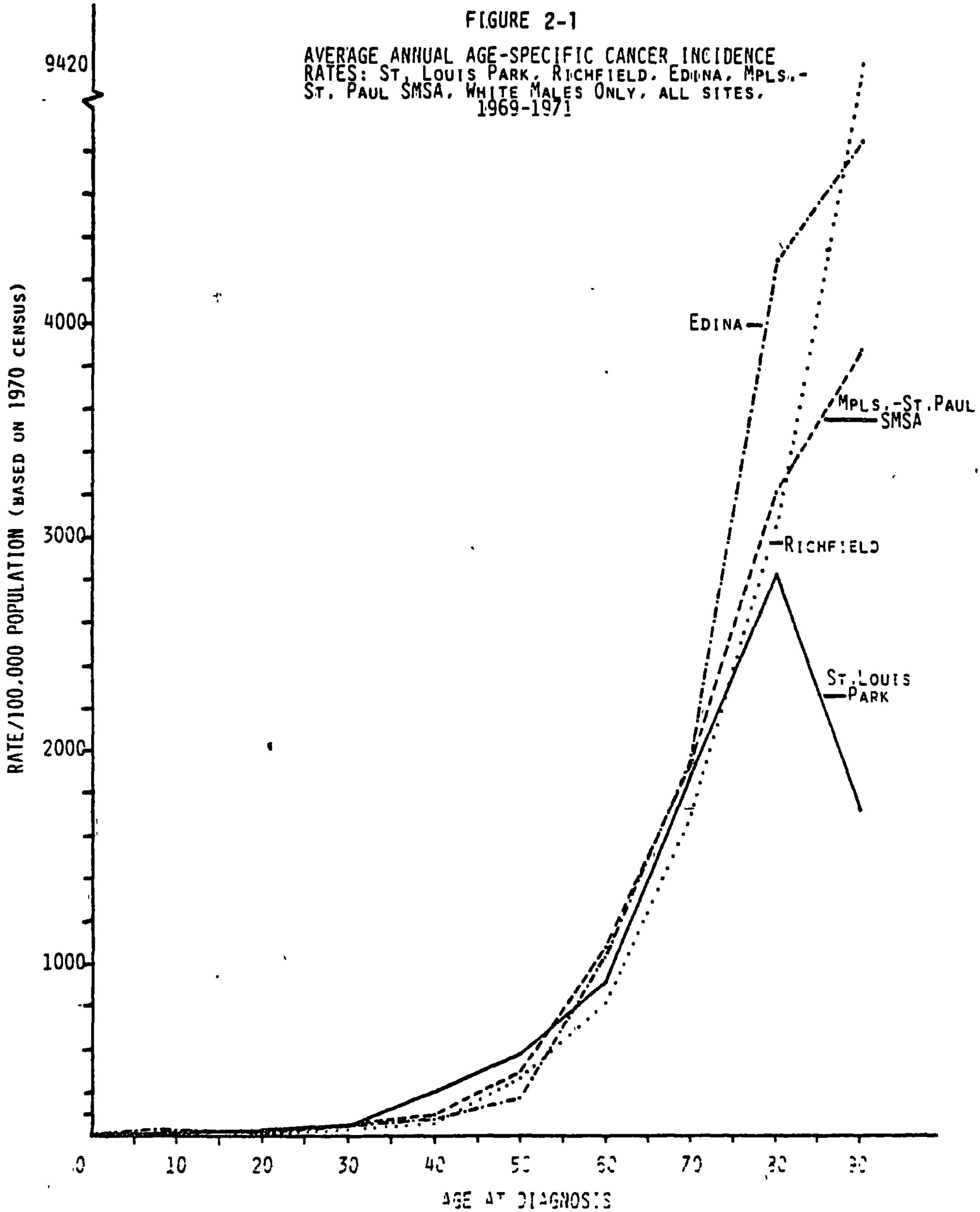
FIGURE 2-1

AVERAGE ANNUAL AGE-SPECIFIC CANCER INCIDENCE RATES: ST. LOUIS PARK, RICHFIELD, EDINA, MPLS.-ST. PAUL SMSA, WHITE MALES ONLY, ALL SITES, 1969-1971



SOURCE: Cancer in the Minneapolis-St. Paul Metropolitan Area, Third National Cancer Survey, 1969-1971 Incidence

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Table 2-2

NUMBER OF CASES, INCIDENCE RATES, AND MANTEL-HAENSZEL SUMMARY CHI-SQUARE VALUES FOR CANCERS OF ALL SITES COMBINED, WHITE FEMALES ONLY, 1969-1971

THREE YEAR TOTAL NUMBER OF CASES

Age Group	St. Louis Park	Edina	Richfield	MSP SMSA*
<15	2	1	0	86
15-24	7	1	1	114
25-34	11	10	9	278
35-44	18	26	12	535
45-54	48	38	38	1174
55-64	78	40	32	1654
65-74	65	30	25	1796
75-84	54	26	20	1590
85+	18	3	8	499
TOTAL	301	175	145	7726

AVERAGE ANNUAL AGE-SPECIFIC INCIDENCE RATES/100,000

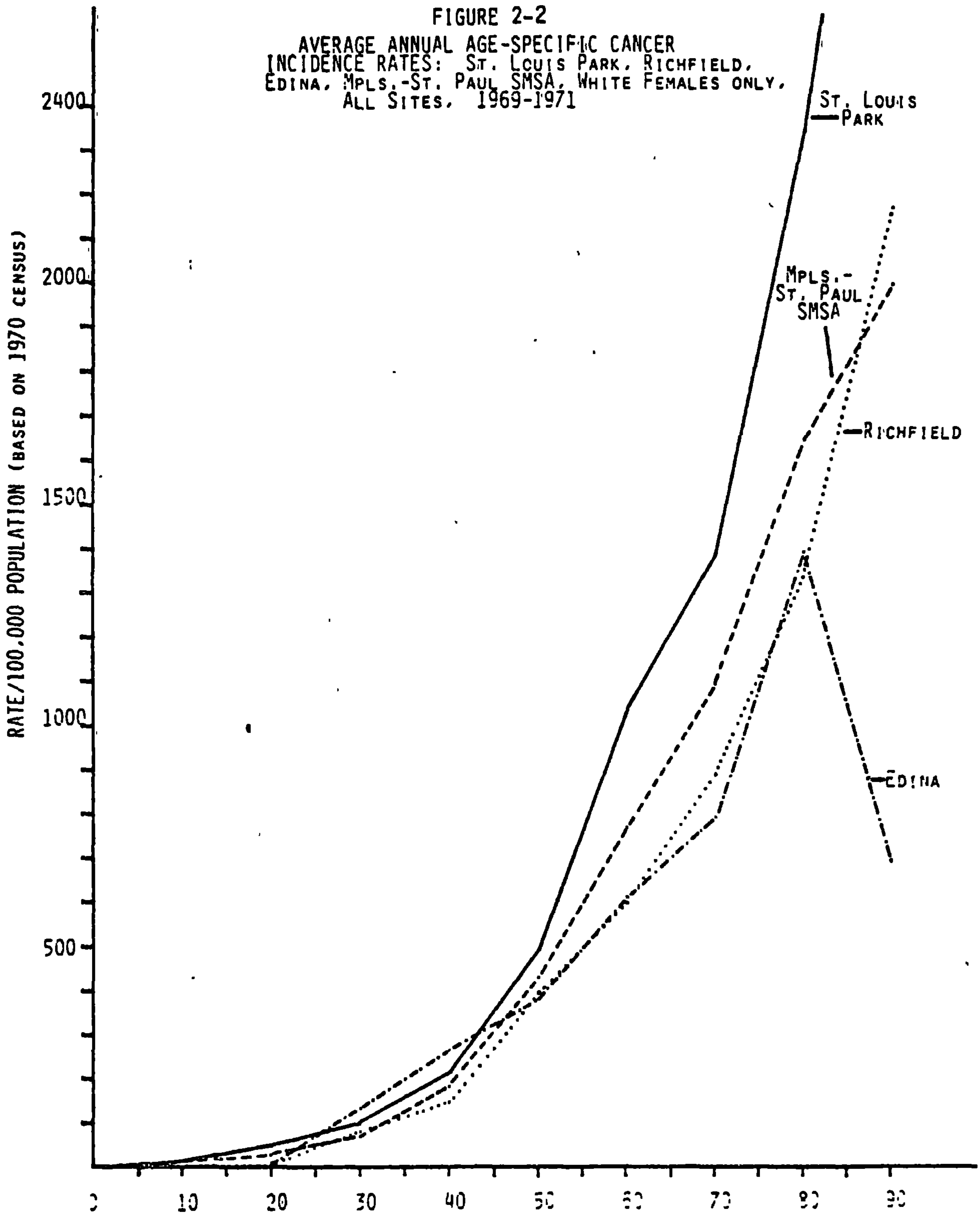
Age Group	St. Louis Park	Edina	Richfield	MSP SMSA*
<15	10.59	5.30	0	10.91
15-24	51.61	10.72	6.29	22.01
25-34	100.90	143.37	87.44	75.30
35-44	219.94	265.36	148.75	185.35
45-54	490.65	383.14	391.19	425.13
55-64	1044.18	615.01	599.25	764.05
65-74	1387.11	793.65	893.18	1094.01
75-84	2340.70	1391.12	1333.33	1646.22
85+	3703.70	694.44	2168.02	1997.28
TOTAL	394.64	259.35	199.34	281.70

AVERAGE ANNUAL AGE-ADJUSTED INCIDENCE RATES/100,000,**

	St. Louis Park	Edina	Richfield	MSP SMSA*
	380.54	240.72	235.47	281.70

Comparisons	CHI-SQUARE VALUES	P VALUES
St. Louis Park vs Edina	19.90	< .0005
St. Louis Park vs Richfield	21.18	< .0005
St. Louis Park vs MSP SMSA	24.31	< .0005

* Minneapolis-St. Paul Standard Metropolitan Statistical Area
** Adjusted to the age distribution of the MSP SMSA population of white females, 1970.



SOURCE: Cancer in the Minneapolis-St. Paul Metropolitan Area, Third National Cancer Survey, 1969-1971 Incidence

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Table 2-3

NUMBER OF CASES, INCIDENCE RATES, AND MANTEL-HAENSZEL SUMMARY CHI-SQUARE VALUES FOR CANCERS OF THE BREAST, WHITE FEMALES ONLY, 1969-1971

THREE YEAR TOTAL NUMBER OF CASES

Age Group	St. Louis Park	Edina	Richfield	MSP SMSA*
<15	0	0	0	0
15-24	0	0	0	1
25-34	1	2	0	53
35-44	10	13	6	215
45-54	23	22	19	448
55-64	33	12	8	499
65-74	14	9	2	447
75-84	12	6	5	369
85+	2	1	1	98
TOTAL	95	65	41	2130
AVERAGE ANNUAL AGE-SPECIFIC INCIDENCE RATES/100,000				
<15	0	0	0	0
15-24	0	0	0	.19
25-34	9.17	28.67	0	14.36
35-44	122.19	132.68	74.38	74.49
45-54	235.10	221.82	195.59	162.23
55-64	441.77	184.50	149.81	230.51
65-74	298.76	238.10	71.45	272.29
75-84	520.16	321.03	333.33	382.05
85+	411.52	231.48	271.00	392.25
TOTAL	124.55	96.33	56.36	77.66
AVERAGE ANNUAL AGE-ADJUSTED INCIDENCE RATES/100,000**				
	112.58	82.39	57.83	77.66

Comparisons	Chi-Square Values	P Values
St. Louis Park vs Edina	3.38	$.10>p>.05$
St. Louis Park vs Richfield	10.85	$.001>p>.0005$
St. Louis Park vs MSP SMSA	13.64	$<.0005$

* Minneapolis-St. Paul Standard Metropolitan Statistical Area

** Adjusted to the age distribution of the MSP SMSA population of white females, 1970.

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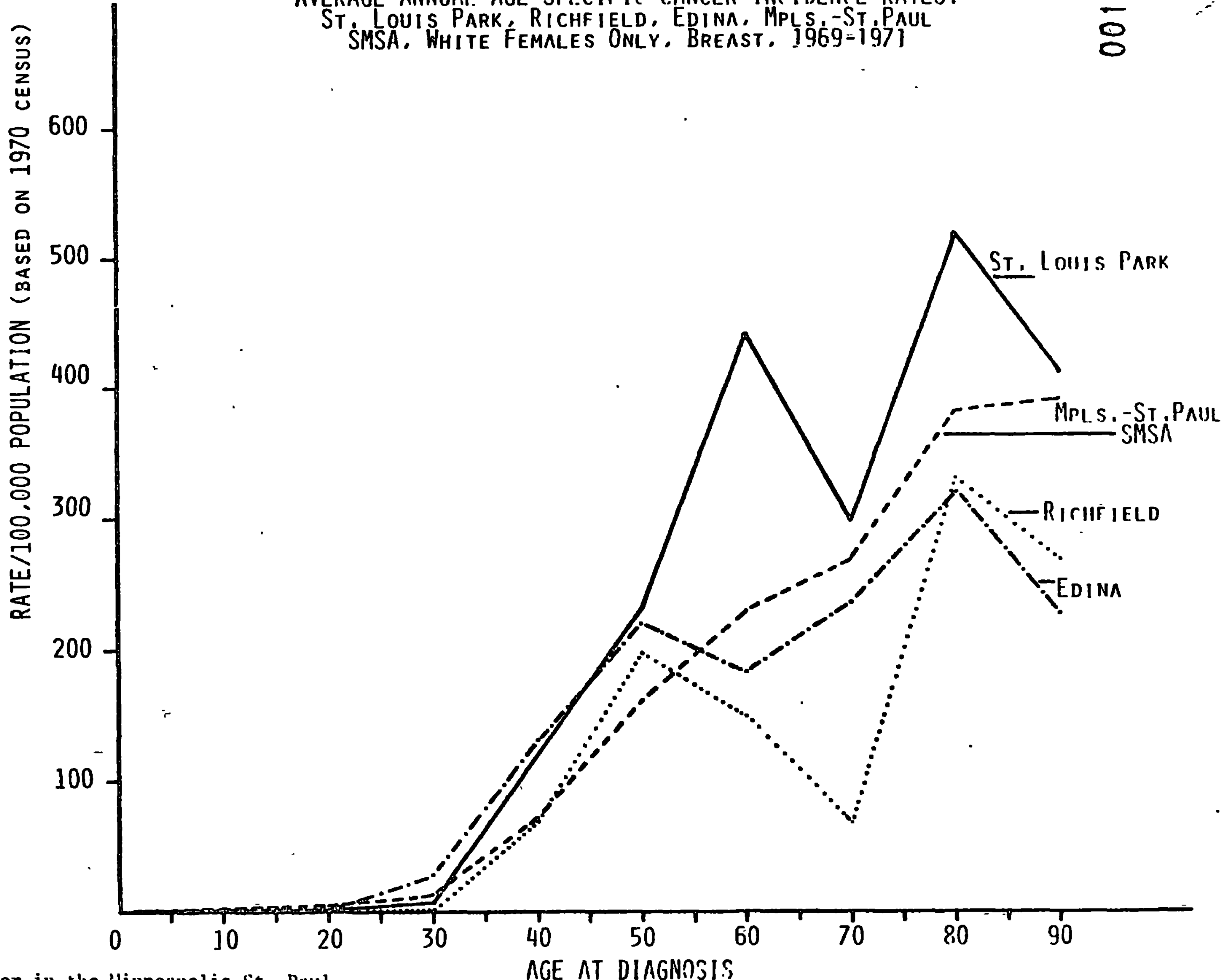
FIGURE 2-3

AVERAGE ANNUAL AGE-SPECIFIC CANCER INCIDENCE RATES: ST. LOUIS PARK, RICHFIELD, EDINA, MPLS.-ST.PAUL SMSA, WHITE FEMALES ONLY, BREAST, 1969-1971



SOURCE: Cancer in the Minneapolis-St. Paul Metropolitan Area, Third National Cancer Survey,

Table 2-4

NUMBER OF CASES, INCIDENCE RATES, AND MANTEL-HAENSZEL SUMMARY CHI-SQUARE VALUES FOR CANCERS OF THE DIGESTIVE SYSTEM, WHITE FEMALES ONLY, 1969-1971

THREE YEAR TOTAL NUMBER OF CASES

Age Group	St. Louis Park	Edina	Richfield	MSP SMSA*
<15	0	0	0	2
15-24	0	0	0	2
25-34	1	2	0	19
35-44	2	1	1	46
45-54	2	5	1	134
55-64	12	6	8	376
65-74	22	7	6	509
75-84	23	7	5	581
85+	5	0	4	208
TOTAL	67	28	25	1877

AVERAGE ANNUAL AGE-SPECIFIC INCIDENCE RATES/100,000

Age Group	St. Louis Park	Edina	Richfield	MSP SMSA*
<15	0	0	0	.25
15-24	0	0	0	.39
25-34	9.17	28.67	0	5.15
35-44	24.44	10.21	12.40	15.94
45-54	20.44	50.41	10.29	48.52
55-64	160.64	92.25	149.81	173.69
65-74	469.48	185.19	214.36	310.05
75-84	996.97	374.53	333.33	601.54
85+	1028.81	0	1084.01	832.53
TOTAL	87.84	41.50	34.37	68.44

AVERAGE ANNUAL AGE-ADJUSTED INCIDENCE RATES/100,000**

	St. Louis Park	Edina	Richfield	MSP SMSA*
	91.13	41.57	48.61	68.44

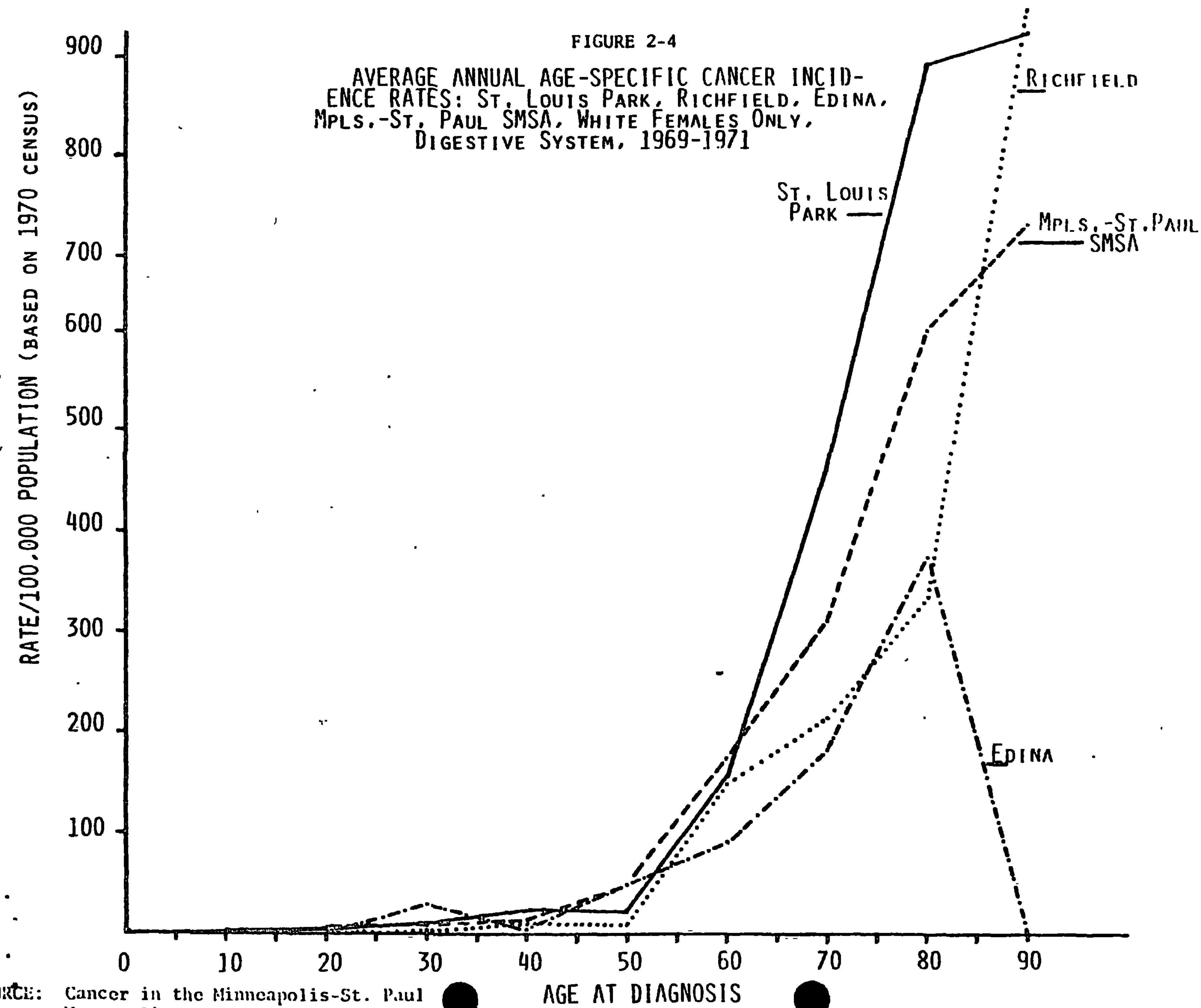
COMPARISONS	CHI-SQUARE VALUES	p VALUES
St. Louis Park vs Edina	9.59	$.005>p>.001$
St. Louis Park vs Richfield	6.28	$.025>p>.01$
St. Louis Park vs MSP SMSA	3.89	$.05>p>.025$

* Minneapolis-St. Paul Standard Metropolitan Statistical Area

** Adjusted to the age distribution of the MSP SMSA population of white females, 1970.

FIGURE 2-4

AVERAGE ANNUAL AGE-SPECIFIC CANCER INCIDENCE RATES: ST. LOUIS PARK, RICHFIELD, EDINA, MPLS.-ST. PAUL SMSA, WHITE FEMALES ONLY, DIGESTIVE SYSTEM, 1969-1971



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SOURCE: Cancer in the Minneapolis-St. Paul Metropolitan Area, Third National

3. Discussion

Breast cancer rates vary considerably with geographic location and with characteristics of the population. Some of the major risk factors for breast cancer include: 1) increasing age; 2) familial history of breast cancer; 3) history of fibrocystic breast disease; 4) absence of or late age at first full-term pregnancy; 5) exposure to high levels of radiation to the chest; 6) upper socioeconomic class; 7) obesity; 8) early age at menarche and 9) late age at menopause. It is also generally accepted that breast cancer occurs more frequently among Jews than among non-Jews.

Given that breast cancer showed the greatest statistical excess and that breast cancer rates vary by the aforementioned characteristics of the population it is of interest to look at those aggregate population characteristics available from the 1970 U.S. Census. Social and economic characteristics have already been addressed (see pages 5 to 6) and will not be included here.

In Table 3-1 we see that St. Louis Park had a greater percentage of its population classified as foreign stock (native of foreign parentage and foreign born) compared with Edina, Richfield and the MSP SMSA. Furthermore, nearly one quarter of St. Louis Park's foriegn stock originated from Russia. If a large number of these Russian foreign stock were Jewish this could contribute to the explanation of excess breast cancer in St. Louis Park.

The only indicators of general residential stability from the Census are the categories: 1) percent of persons 5 years old and over living in the same house from 1965 to 1970; and 2) percent of persons 5 years old and over living in the same county from 1965 to 1970. Unfortunately there is no published breakdown of these categories by age (see Table 3-2).

For the first category St. Louis Park had only 35.5 percent compared to 58.8 and 59.2 percent for Richfield and Edina respectively. For the second category however, St. Louis had 94 percent compared to Edina's 94.6 percent

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and Richfield's 81.4 percent. So although a smaller percentage of St. Louis Park's population lived in the same house for the 5 years preceding the Census, a greater percentage lived in the same county and therefore possibly the same community but in a different house.

The mobility/stability factor or migration variable in populations is essential to consider when dealing with possible environmental exposures due to the complicated interactions of dose-response, latent period and duration of residence.

The effect of migration is greatest for diseases with long latent periods such as cancer. In-migrants must have sufficient time to manifest any effects of an environmental exposure, yet as duration of residence increases the proportion of the population with that duration decreases.

Furthermore, the amount of migration that takes place within and between areas varies by age and sex. Migration is highly age-selective. Younger people are more likely than older people to migrate in and out of an area of exposure and thus to diminish excess rates. On the other hand, selective migration of younger healthier people out of an area would leave that area with higher risk among its remaining population. The proportion of the population with a given minimum duration generally increases with age. It follows then that a disease with a higher incidence at older ages is more likely to occur near the location of its environmental cause than a younger disease.

It is apparent that the difference between true risk and estimated risk can be great due to migration. In subsequent studies a length-of-residence variable will be used to remove the migration effect.

All incidence rates in this study were age-adjusted to remove the confounding influence of age. There are, however, important environmental (social and physical), economic and political differences between a younger population and an older population which the age-adjustment process does not take into consideration. For example, an older population will tend to have fewer cars, less industry and more nursing homes and apartments.

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There are several summary indicators of the aging of a population. The best indicator is an increase over time in the ratio of aged persons (65 years old and over) to children (0 to 14 years old). An aged-child ratio of less than 15 indicates a young population whereas a ratio of greater than 30 indicates an old population. In 1960 St.Louis Park's population was considered young by this standard with an aged-child ratio of 12.5. In 1970, however, this ratio had increased to 32.5 indicative of considerable aging of the population. Edina, Richfield and the SMSA population also aged from 1960 to 1970 but their ratios remained in the intermediate range.

When we examine percent white females by age for each comparison area we find that Edina had the highest percent 35-54 years old; Richfield had the highest percent 15-24 years old and the lowest percent 45 years old and over; St.Louis Park had the highest percent 55 years old and over; and the SMSA had the lowest percent in the middle years 15 to 64 years old and the highest percent at either extreme i.e. less than 15 years old and 65 years old and over. (Table 3-3, Figures 3-1, 3-2, and 3-3).

Table 3-1: Percent Native of Native Parentage and Percent Foreign Stock: Edina, Richfield, St. Louis Park and MSP SMSA. 1970.

	Edina	Richfield	St. Louis Park	MSP SMSA*
Total Population	44,014	47,237	48,893	1,813,647
% native of native parentage	81.0	83.1	74,6	82.3
% native of foreign parentage	16.0	14.6	19.9	14.7
% foreign born	2.9	2.4	5.4	3.0
% Foreign stock	18.9	16.9	25.4	17.7
Total foreign stock	8,339	8,002	12,407	321,627
% United Kingdom	6.8	4.8	3.3	4.4
% Poland	1.1	1.8	6.7	4.9
% Sweden	17.4	23.2	11.3	17.4
% Germany/Austria	12.5	15.4	10.1	18.3
% Czechoslovakia	2.5	3.3	1.3	2.8
% USSR	3.2	1.7	23.4	4.2
% All others not reported	34.3	34.1	31.6	30.9

*Minneapolis-St. Paul Standard Metropolitan Statistical Area

Source: 1970 Census of Population, General Social and Economic Characteristics, Minnesota, PC(1)-C25 Minn., March, 1972.

Table 102 Social Characteristics for Places of 10,000 to 50,000: 1970, pp.25-358, 25-359, 25-360.

Table 3-2: Percent Live in Same County and Percent Live in Same House From 1965 to 1970: Edina, Richfield, St. Louis Park, and MSP SMSA.

	Edina	Richfield	St. Louis Park	MSP SMSA
Persons, 5 years old and over	41,162	43,265	44,895	--
% live in same county 1965-70	84.6	81.4	94.0	--
% live in same house	59.2	58.8	35.5	52.5

Source: 1970 Census of Population and Housing, Census Tracts, Minneapolis-St. Paul Standard Metropolitan Statistical Area, Minnesota, PHC(1)-132, March, 1972.

Table P2 Social Characteristics of the Population: 1979, p. p-37.

Table 3-3. Percent White Population by Age: Edina, Richfield, St. Louis Park & MSP SMSA, 1970

		Edina	Richfield	St. Louis Park	MSP SMSA
% of total population that is white		99.7	99.4	99.2	97.2
White population		43,904	46,927	48,509	1,763,769
% white population by age					
	<15	29.4	27.5	26.5	30.4
	15-24	14.4	20,7	17.2	18.2
	25-34	9.7	14.7	14.6	13.9
	35-44	14.2	10.9	10.7	10.9
	45-54	14.9	13.3	12.8	10.2
	55-64	9.4	7.4	9.5	7.6
	65-74	5.2	3.4	5.5	5.2
	75-84	2.3	1.7	2.6	2.9
	85+	.5	.4	.5	.7
	TOTAL	100.0	100.0	99.9	100.0
% females by age	<15	14.3	13.3	13.0	14.9
	15-24	7.1	11.3	9.3	9.8
	25-34	5.3	7.3	7.5	7.0
	35-44	7.4	5.7	5.6	5.5
	45-54	7.5	6.9	6.7	5.2
	55-64	4.9	3.8	5.1	4.1
	65-74	2.9	2.0	3.2	3.1
	75-84	1.4	1.1	1.6	1.8
	85+	.3	.3	.3	.5
	TOTAL	51.1	51.7	52.3	51.9
Median Age	Male	30.1	25.6	27.8	25.2
	Female	33.1	26.4	29.4	26.5

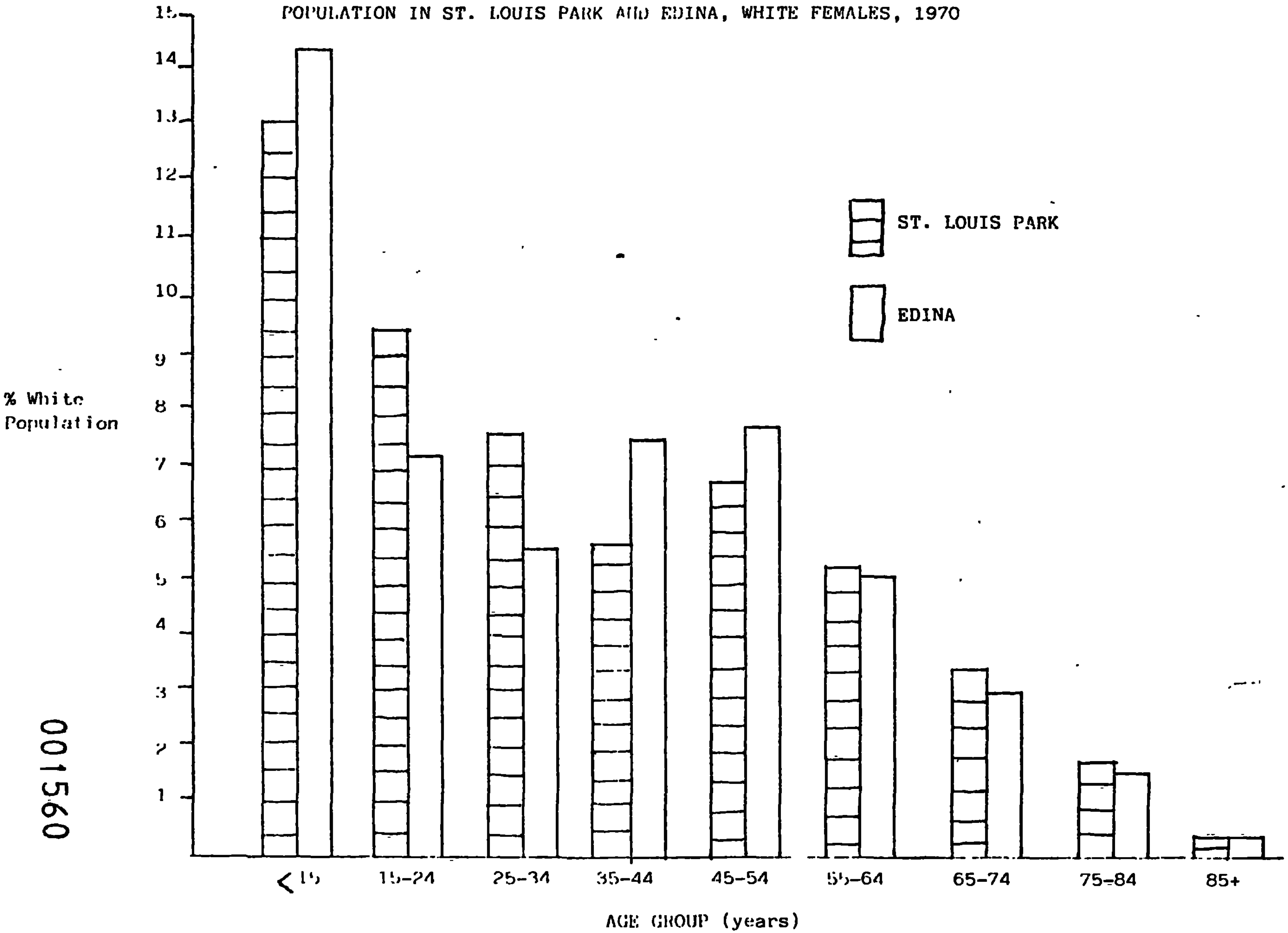
Source: 1970 Census of Population, General Population Characteristics, Minnesota, PC(1)-B25 Minn., September, 1971.

Table 24. Age by Race and Sex, for Areas and Places: 1970, pp. 25-85.

Table 28 Age by Race and Sex, for Places of 10,000 to 50,000: 1970, pp. 25-104, 25-109, 25-110

FIGURE 3-1

COMPARISON OF THE PERCENT DISTRIBUTION OF THE AGE OF THE POPULATION IN ST. LOUIS PARK AND EDINA, WHITE FEMALES, 1970



SOURCE: 1970 Census of Population, General Population Characteristics, Minnesota, PC(1)-B25, Sept. 1971.

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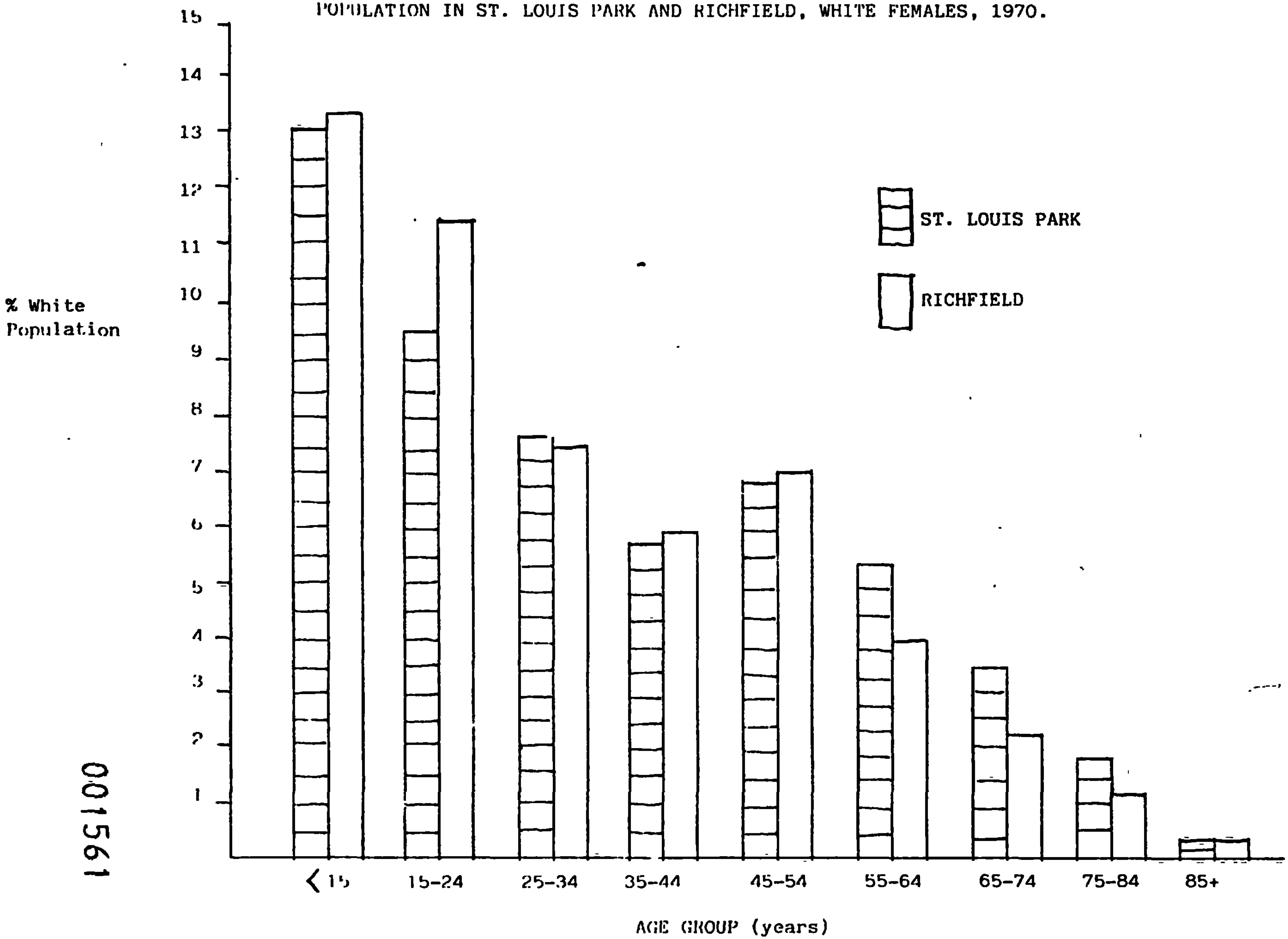
FIGURE 3-2

COMPARISON OF THE PERCENT DISTRIBUTION OF THE AGE OF THE POPULATION IN ST. LOUIS PARK AND RICHFIELD, WHITE FEMALES, 1970.



SOURCE: 1970 Census of Population, General Population Characteristics, Minnesota, PC(1)-B25, Sept. 1971.

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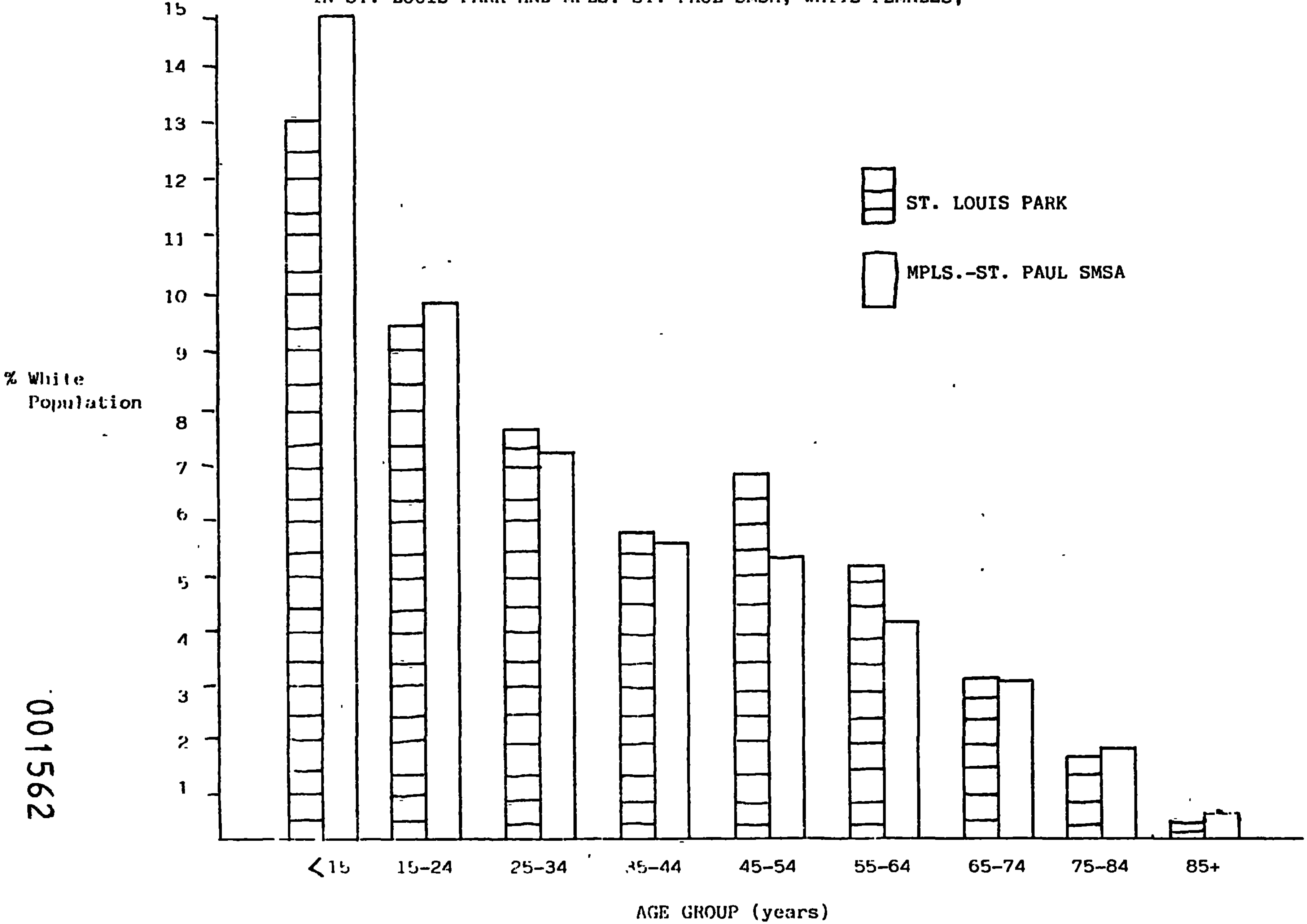
FIGURE 3-3

COMPARISON OF THE PERCENT DISTRIBUTION OF THE AGE OF THE POPULATION IN ST. LOUIS PARK AND MPLS.-ST. PAUL SMSA, WHITE FEMALES,



SOURCE: 1970 Census of Population, General Population Characteristics, Minnesota, PC(1)-B25, 1971.

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In order to evaluate the geographic distribution of St.Louis Park breast cancer cases in relation to the former Republic Creosote site I constructed a spot map of newly diagnosed cases of breast cancer by residence at time of diagnosis, 1969 to 1971, for St.Louis Park white females. The greatest concentration of cases appeared to be east and southeast of the creosote site. But a spot map simply shows the location at which an event took place or at which a condition exists. It does not provide a measure of the risk of that event occurring in a particular place because the size of the population at risk of that event is not taken into consideration. To do this I drew St. Louis Park's population by census tract and sex (Figures 3-4 and 3-5) then constructed an area map by mapping breast cancer incidence rates by census tract. (Table 3-4 and Figure 3-6). It is of interest to note that the first, second and third highest incidence of breast cancer was found east and southeast of the site which is the general direction of regional groundwater flow and presumably contamination flow. Also census tract 221.02 to the north of the creosote site and the location of contaminated wells number 7 and 9 had the fourth highest incidence rate.

Although regional groundwater flow is to the southeast, local groundwater flow is greatly influenced by the location of each pumping well and the number of wells at any one location. It is not surprising that the four wells found to be contaminated were north of the creosote site because this is where most of St.Louis Park's high service pumping wells are located (Figure 3-7).

None of the 95 St.Louis Park 1969 to 1971 newly diagnosed cases of breast cancer resided in a St.Louis Park nursing home at the time of their diagnosis (Figure 3-8).

Figure 3-4

CENSUS TRACT DIVISIONS

ST. LOUIS PARK

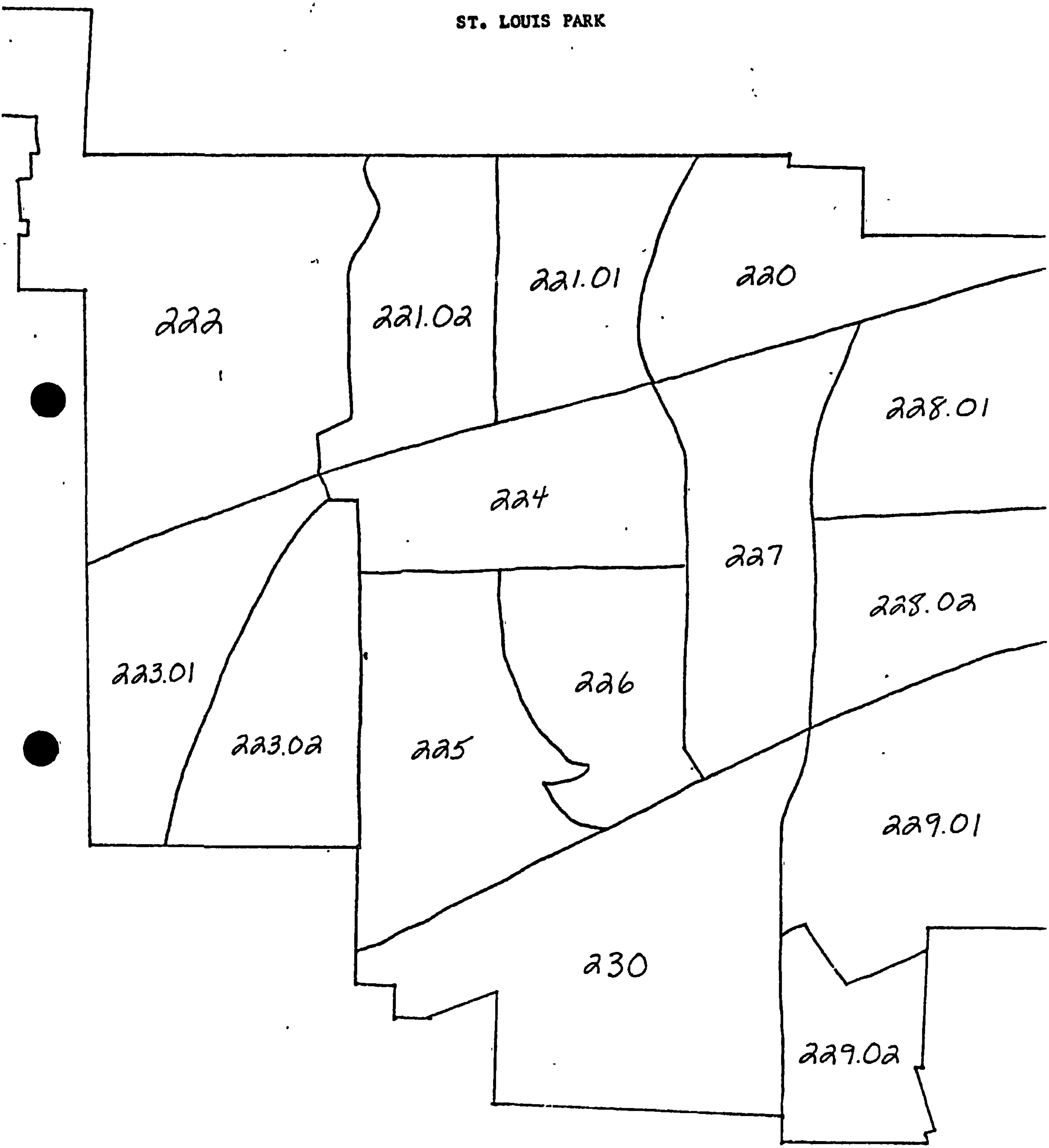
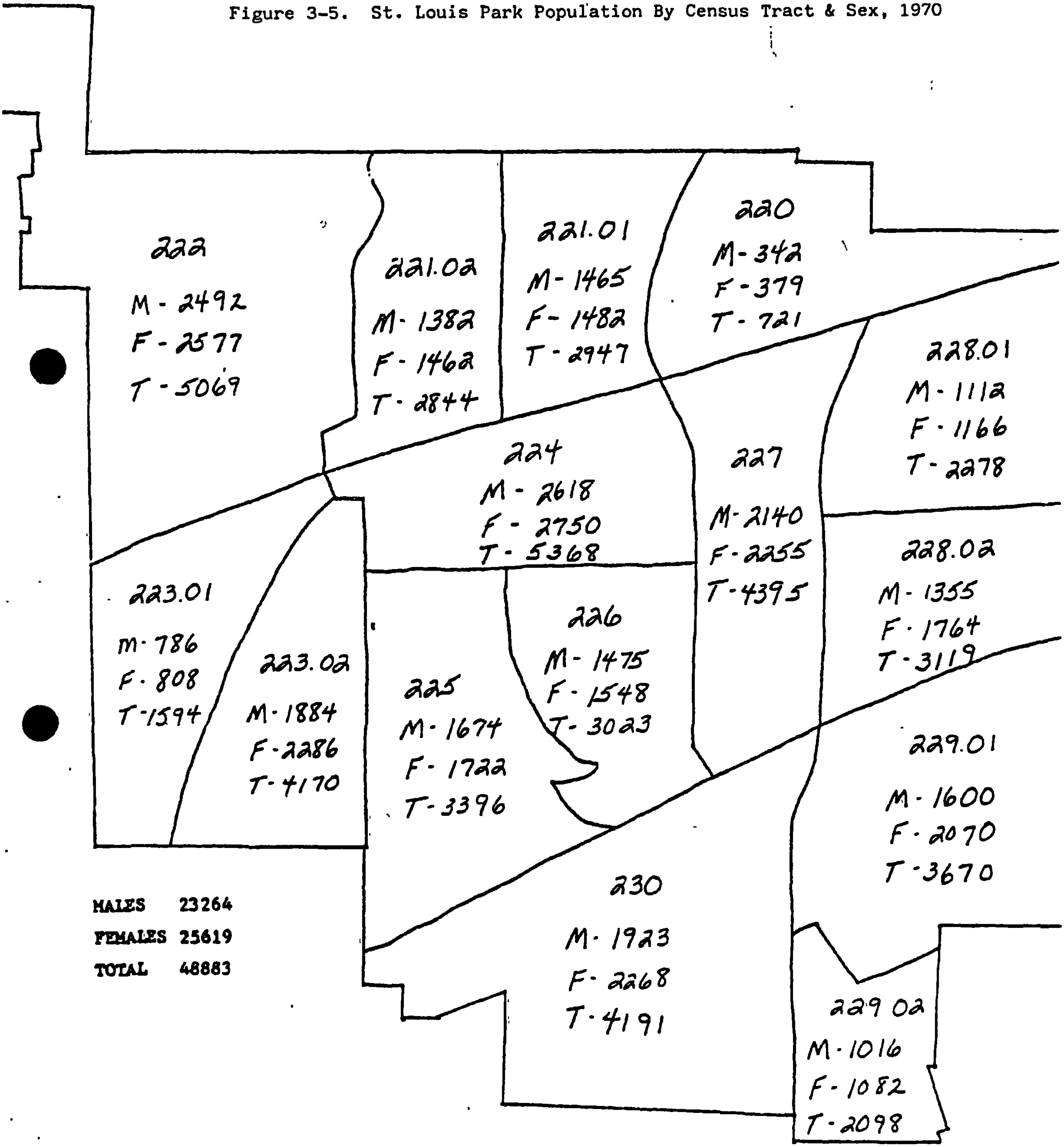


Figure 3-5. St. Louis Park Population By Census Tract & Sex, 1970



MALES	23264
FEMALES	25619
TOTAL	48883

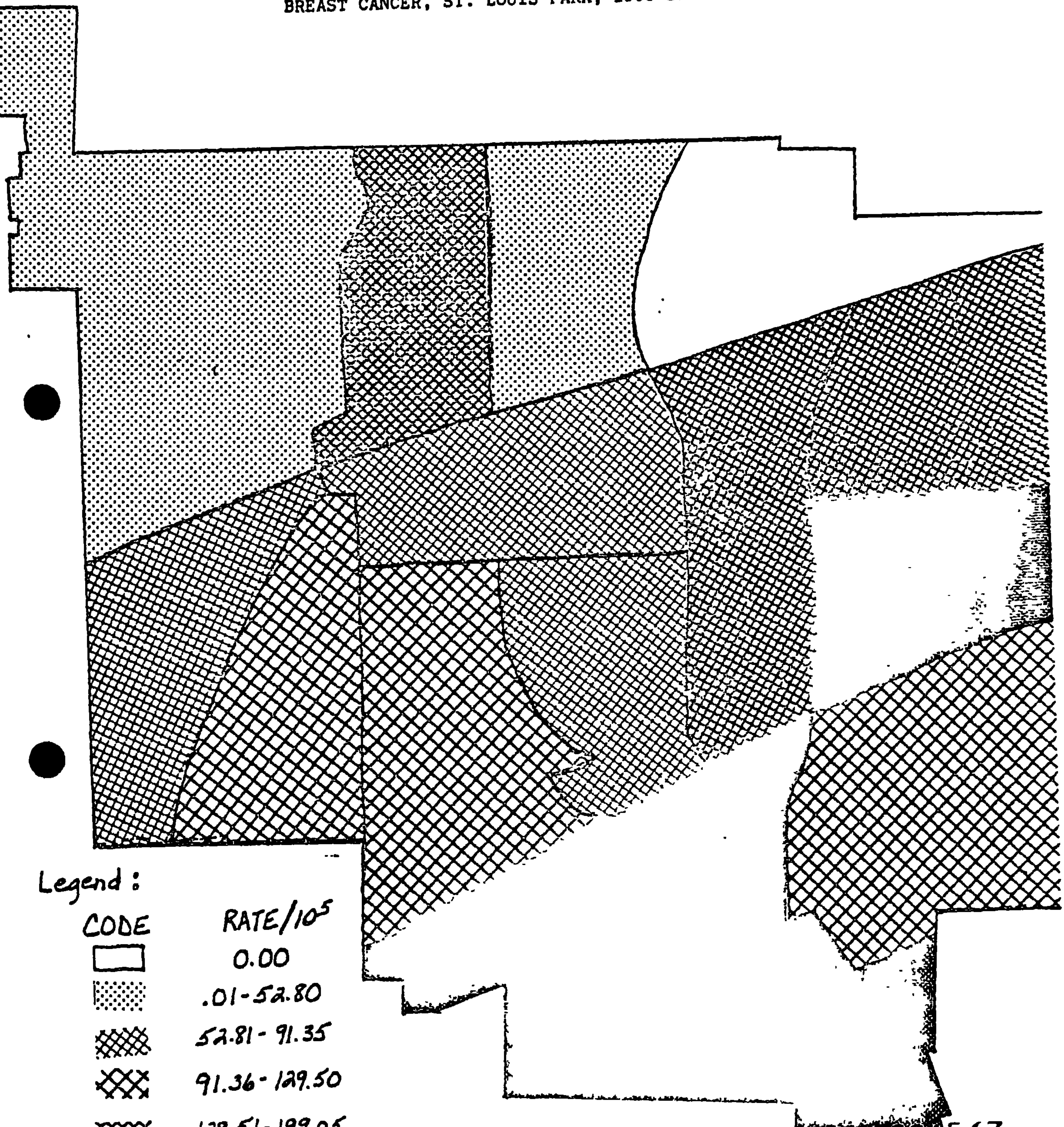
TABLE 3-4

RANK-ORDER OF AVERAGE ANNUAL BREAST CANCER INCIDENCE RATES per 100,000 WHITE FEMALES by CENSUS TRACT, ST. LOUIS PARK, 1969-1971

CENSUS TRACT	RATE/100,000
220	0.0
221.01	22.5
222	32.9
224	72.7
223.01	82.5
226	86.1
229.01	96.6
223.02	102.1
225	116.1
228.01	142.9
227	162.6
221.02	182.4
229.02	215.7
230	220.5
228.02	264.6

FIGURE 3-6. AREA MAP OF FEMALE

BREAST CANCER, ST. LOUIS PARK, 1969-1971



Legend:

CODE	RATE/10^5
(blank)	0.00
(fine dots)	.01-52.80
(fine crosshatch)	52.81-91.35
(coarse crosshatch)	91.36-129.50
(dense crosshatch)	129.51-199.05
(dark stipple)	199.06-264.60

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Figure 3-7. Location of the Former Republic Creosote Site, Location

[redacted]

NON-RESPONSIVE

FIGURE 3-8

[redacted]

NON-RESPONSIVE

References

1. Polissar, L. The Effect of Migration on Comparison of Disease Rates in Geographic Studies in the United States Am. J. Epi 3(2):175-182, 1980.

2. Stockwell, E.G. The Methods and Materials of Demography Condensed Edition, Academic Press, New York, New York 1976. pp. 113-142.

001570

4. Summary

PRELIMINARY SURVEY OF CANCER RATES IN A COMMUNITY EXPOSED TO LOW LEVELS OF CREOSOTE COMPONENTS IN MUNICIPAL WATER

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In November, 1978, the Minnesota Department of Health detected minute (nanogram per liter) quantities of various polynuclear aromatic hydrocarbons (PAH), including pyrene, fluoranthene, anthracene, and naphthacene, in several municipal and industrial wells in the city of St. Louis Park, a suburb of Minneapolis (1). Although there are no official U.S. standards for PAH in water supplies, four municipal wells were closed immediately because the amounts exceeded the World Health Organization's recommendation for safe levels in drinking water (2). PAH compounds were not detected in the remaining ten municipal wells.

The PAH compounds apparently originated from the site of a plant which distilled coal-tar products and treated wood with creosote from 1917 to 1972. During this time, wastes from the plant's operations were deposited on the surface of the site, allowing contamination of the groundwater reservoirs below.

It is not known how long PAH compounds have been in the St. Louis Park water supply, since techniques for their detection in water have only been available in the past few years (3). A well drilled in 1932, however, was shut down within a few months due to a creosote-like odor and taste of the water, and it is possible that PAH compounds have been in the municipal water for many years or decades in low concentrations.

The occurrence of PAH in the environment is of concern because of their demonstrated carcinogenicity for animals and/or mutagenicity for bacteria (4-9). There appear to be no epidemiologic studies of human populations exposed to low levels of PAH in water supplies, although the association of occupational skin cancer with creosote and coal-tar compounds has long been known (10-13).

The Minneapolis-St. Paul area, including St. Louis Park, was part of the Third National Cancer Survey (14) conducted for the three years, 1969 to 1971. All hospital records in the five county Twin Cities area were searched for cancer diagnoses, and abstracts of cancer records were coded on computer tape. Because of the availability of these records on tape, albeit for a limited three year period of time, it was decided to compare cancer incidence rates in St. Louis Park with those in the nearby municipalities of Edina and Richfield and in the entire Minneapolis-St. Paul Standard Metropolitan Statistical Area (SMSA).

METHODS

Incidence rates for 45 types or sites of cancer were calculated for St. Louis Park, Edina, Richfield, and the Minneapolis-St. Paul SMSA using data from the Third National Cancer Survey for the three years, 1969-1971. Richfield was selected because it was a SMSA suburb similar to St. Louis Park in social and economic characteristics such as median school years completed, percent high school graduates, occupation and median and mean family income. Edina was selected because the creosote contamination was believed, at that time, to be moving toward Edina. The entire SMSA was used as the major comparison area. Incidence rates were age-adjusted to the SMSA populations of white males and white females respectively. Calculations were done of average annual age- and sex-specific cancer incidence rates, age-adjusted incidence rates, standard incidence ratios (SIR), Mantel-Haenszel overall summary Chi-squares (15, 16) and Z statistics. The latter two statistics are used to assess the significance of the difference between two rates after adjusting for age. Population denominator data were taken from the 1970 U.S. Census (17).

RESULTS

For males, no cancer rates in St. Louis Park were statistically significantly different fromthose in the three comparison areas. Among females, age-adjusted rates for all cancer sites combined, for breast cancer, and for cancers of the gastrointestinal tract were higher in St. Louis Park than in Edina, Richfield, and the SMSA. The excess in gastrointestinal cancer rates for females was only slightly significant ($P < .05$) but both all cancer sites combined and breast cancer had differences with a high degree of statistical significance ($P < .0005$). Further details of the significant comparisons are given in Table I.

DISCUSSION

In the absence of epidemiologic literature on ingested exposure to PAH, it is of interest to note that rats fed one PAH compount--3-methylcholanthrene--develop mammary carcinoma in high frequency and these tumors occur almost exclusively in females (18-20). Other PAH compounds produce a variety of tumors in animals (4).

Breast cancer rates vary considerably with geographic location and with characteristics of the population (21-24). In the Third National Cancer Survey (14), for example, the rates varied from 59 to 83 per 100,000 white females per year in the nine different study areas. In a recent review of the epidemiology of human breast cancer, Kelsey has summarized the influence of major factors known to influence breast cancer rates, expressing the results as relative risks (RR)--the ratio of case rates in a population with the factor to the rate in those without the factor (24). These include: 1. First degree relative with breast cancer (RR of 2-4); 2. Absence of or late age at first full-term pregnancy (RR of 2-4); 3. History of fibrocystic disease of the breast (RR of 2-4); 4. Exposure to high levels of radiation to the chest (RR of 2-4); 5. Upper socio-economic class (RR of 2-4); 6. Obesity (RR of 2-4); and 8. Early age at menarche and late age at menopause (RR of 1.1 - 1.9). Rates given in the literature for Jewish populations are contradictory, varying from less than to higher than those for non-Jewish whites (25-27). The contribution of these factors to the difference in breast cancer rates between St. Louis Park and the comparison areas cannot be evaluated without further information about the individual cases. Because of the sizeable population with Jewish ancestry, estimated to be 20% in 1971 (28), the influence of this factor is of particular interest, but would not explain the 1.5 fold difference in rates even if 20% of the St. Louis Park breast cancer cases were Jewish and a two-fold relative risk existed.

The lack of elevation in the rates for the great majority of cancer types is reassuring, but factors responsible for the elevation in breast cancer rates in St. Louis Park need to be investigated. Further interpretation must await interviews of the 95 cases of breast cancer or their families and an appropriate control group. The results of such a detailed case-control study, now in the planning phases, may explain the elevated breast cancer rates in St. Louis Park on the basis of the frequencies of known risk factors. If this is not the case, further studies to explore a possible relationship with the water supply must be considered.

At the present time, the elevated incidence of breast cancer cannot be attributed to the water contamination, although the limited information available does not rule out such an association. It should be noted that the wells found to be contaminated have been closed, presumably reducing any hazard which may have been present.

We gratefully acknowledge the advice and assistance of Marcus Kjelsberg, Ph.D., Chairman, Division of Biometry and of Leonard Schuman, M.D., M.S., Chairman, and Jack Mandel, M.P.H., Assistant Director, Division of Epidemiology, University of Minnesota School of Public Health, Minneapolis, Minnesota. Dr. Schuman was Director of the Minneapolis-St. Paul Component of the Third National Cancer Survey, and Kindly provided access to the data.

TABLE I

Cancer Incidence Rates for Total Cancers and Breast Cancer
St. Louis Park and
Three Comparison Populations
White Females Only, 1969 to 1971

		Breast Cancer		All Cancers	
	Population	Total Cases 1969-1971	Average Annual Age-Adjusted Rate* per 100,000 pop.	Total Cases	Average Annual Age-Adjusted Rate* per 100,000 pop.
St. Louis Park	25,424	95	113	301	381
Edina	22,492	65	82	175	241
Richfield	24,247	41	58	145	235
MSP SMSA	914,218	2130	78	7726	282

*Rates per 100,000 white females, adjusted to the MSP SMSA population of white females, 1970.

Mantel-Haenszel Summary Chi-Square Values and ρ-Values

	CHI-SQUARE		ρ-VALUE	
Comparison	Breast Cancer	All Cancers Females	Breast Cancer	All Cancers Females
St. Louis Park vs Edina	3.38	19.90	$.05 < \rho < .1$	$< .0005$
St. Louis Park vs Richfield	10.85	21.18	.001	$< .0005$
St. Louis Park vs SMSA	13.64	24.31	$< .0005$	$< .0005$

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The Mantel-Haenszel overall summary chi-square test that we used is a one-degree-of freedom procedure for testing if the rate of occurrence of an observed event is the same for two groups after adjusting for different age or other distributions in the two groups. The overall summary chi-square that is calculated essentially compares two age-adjusted rates. In essence, for each age interval one has a 2X2 contingency table (see below) where the age specific rates are defined by the rates for the two populations combined. Adjustment is by the indirect method, applying the mean rate for each age interval to one of the two groups. For that group, the difference between the total number of observed events and the total number expected is compared to its standard error. The same procedure applied to the other group would give identical results, so that it does not matter which group is used for the calculation.

If the chi-square value (with one degree of freedom and continuity correction) thus obtained exceeds the 5% cut-off point, 3.84, the hypothesis of equal overall adjusted rates is rejected.

Example of a 2X2 contingency table:

		Pop. 1	Pop. 2	
Age Group > 15	C	n_{ijk}	$n_{ijk'}$	N_{ij}
	$\bar{C}$			
		Pijk	Pijk'	P_{ij}

The Mantel-Haenszel overall summary chi-square test is a reasonable overall significance test which has power for alternative hypotheses where there is a consistent association in the same direction over the various subclassifications between the disease and a study factor.

Example 1.

equality of rates

vs.

all St. Louis Park > all Richfield

001580

equality of rates

vs.

young St. Louis Park > young Richfield

OR

old St. Louis Park < old Richfield

If, however, there is a "flip-flop" occurrence of events then the Mantel-Haenszel overall significance test is not good at picking up significance. It could be that this is what is going on with the males in St. Louis Park; maybe the young are not of interest.

In this study a result that is significant at a prespecified significance level is interpreted as meaning that one of the two comparisons has a statistically significant greater incidence of cancer than does the other. The way you tell which of the two comparison cities has the higher incidence is by looking at the age-specific rates and for a consistency in one direction.

The Z statistic looks at the same thing as the Mantel-Haenszel summary chi-square statistic, but in a slightly different way. Both compare age-adjusted rates, but the weights assigned are different. The Z statistic has as its weights the white male or white female age populations of the Minneapolis-St. Paul SMSA as the standard (direct method of adjustment). The Mantel-Haenszel has, as its weights, the mean incidence rates from the combined populations of the comparisons as the standard (indirect method of adjustment). Furthermore, with the Z we changed all cells with zero cases to .5 (½ a person) so that no rates would be zero, and lastly, the Z was calculated without a continuity correction.

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SLPOUT1 All Sites
7/25/79

SITE = -999

THREE YEAR TOTAL NUMBER OF CASES 1969-71

	MALE				FEMALE			
	ST L PARK	EDINA	RICHFIELD	SMSA	S L PARK	EDINA	RICHFIELD	SMSA
LT 15	2.00	5.00	2.00	86.00	2.00	1.00	0	86.00
15-24	[illegible]	1.00	0	103.00	7.00	1.00	1.00	114.00
25-34	4.00	2.00	1.00	140.00	11.00	10.00	9.00	278.00
35-44	15.00	8.00	1.00	274.00	18.00	26.00	12.00	535.00
45-54	[illegible]	17.00	[illegible]	758.00	44.00	38.00	38.00	1174.00
55-64	46.00	47.00	31.00	1603.00	74.00	40.00	32.00	1654.00
65-74	57.00	[illegible]	31.00	1380.00	65.00	30.00	25.00	1796.00
75-84	37.00	50.00	[illegible]	1715.00	54.00	26.00	20.00	1590.00
85 +	6.00	10.00	13.00	450.00	14.00	3.00	8.00	499.00
ALL AGES	202.00	196.00	132.00	7129.00	301.00	175.00	145.00	7726.00

AVERAGE ANNUAL INCIDENCE RATES/100000 1969-1971

LT 15	10.15	25.13	10.01	10.70	10.59	5.30	0	10.91
15-24	26.10	10.41	0	23.18	51.61	10.72	6.29	22.01
25-34	38.48	34.03	[illegible]	38.23	100.90	143.37	87.44	75.30
35-44	201.86	89.37	[illegible]	95.65	219.94	265.36	148.75	185.35
45-54	[illegible]	174.66	[illegible]	294.00	490.65	383.14	391.19	425.13
55-64	721.23	815.07	[illegible]	658.12	1044.18	615.01	599.25	764.05
65-74	1690.19	1702.13	[illegible]	1772.26	1387.11	793.65	893.18	1094.01
75-84	2612.44	[illegible]	[illegible]	3006.87	2340.70	1391.12	1333.33	1646.22
85 +	1515.15	[illegible]	[illegible]	3675.57	3103.70	694.44	2168.02	1997.28
ALL AGES	291.70	305.12	[illegible]	279.72	394.64	259.35	199.34	281.70

Z STATISTIC

	1. MALE	2. FEMALE
STP - EDINA	.9419	* [illegible]
STP - RICH	.2006	* [illegible]
EDINA-RICH	1.1731	[illegible]

Uses 3 yr adj. rates,
direct method:
1. SMSA males as std
2. SMSA females as std
All-zeros → .5

2 sided test
H_0 : adj. rate A = adj. rate B
When Z > 1.96, P value = .05
When Z > 2.58, P value = .01

STANDARD MORBIDITY RATIOS

	MALE	FEMALE
ST L PARK	.97	1.33
EDINA	1.02	[illegible]
RICHFIELD	.86	[illegible]

AVERAGE ANNUAL AGE ADJUSTED INCIDENCE RATES/100000 1969-71

	1. MALE	2. FEMALE
ST L PARK	[illegible]	[illegible]
EDINA	[illegible]	[illegible]
RICHFIELD	[illegible]	[illegible]

Direct method
1 SMSA males as std
2. SMSA Females as std

CHI-SQUARE VALUES FOR COMPARING CITIES

COMPARISON	MALE	FEMALE	AGE-SEX ADJ
ST L PARK - EDINA	.17	[illegible]	[illegible]
ST L PARK - RICHFIELD	1.21	21.18**	18.07**
ST L PARK - SMSA	.18	[illegible]	[illegible]
EDINA - RICHFIELD	[illegible]	.18	1.55
EDINA - SMSA	[illegible]	[illegible]	1.12
RICHFIELD - SMSA	[illegible]	[illegible]	[illegible]

SITE = -999

All Sites Cancer Combined

0015853

BREAST

SITE = 74

THREE YEAR TOTAL NUMBER OF CASES 1969-71

	MALE				FEMALE			
	S L PARK	EDINA	RICHFIELD	SMSA	S L PARK	EDINA	RICHFIELD	SMSA
LT 15	0	0	0	0	0	0	0	0
15-24	0	0	0	0	0	0	0	1.00
25-34	0	0	0	0	1.00	2.00	0	53.00
35-44	0	0	0	0	10.00	13.00	6.00	215.00
45-54	1.00	0	0	1.00	23.00	22.00	19.00	448.00
55-64	0	0	0	4.00	33.00	12.00	8.00	499.00
65-74	0	0	0	2.00	14.00	9.00	2.00	447.00
75-84	0	0	0	3.00	12.00	6.00	5.00	369.00
85 +	0	0	0	0	2.00	1.00	1.00	98.00
ALL AGES	1.00	0	0	10.00	95.00	65.00	41.00	2130.00

AVERAGE ANNUAL INCIDENCE RATES/100000 1969-1971

LT 15	0	0	0	0	0	0	0	0
15-24	0	0	0	0	0	0	0	.19
25-34	0	0	0	0	9.17	28.67	0	14.36
35-44	0	0	0	0	122.19	132.68	74.38	74.49
45-54	11.36	0	0	.34	235.10	221.82	195.59	162.23
55-64	0	0	0	2.14	441.77	184.50	149.81	230.51
65-74	0	0	0	1.78	298.76	238.10	71.45	272.29
75-84	0	0	0	5.26	520.16	321.03	333.33	382.05
85 +	0	0	0	0	411.52	231.48	271.00	392.25
ALL AGES	1.44	0	0	.39	124.55	96.33	56.36	77.66

Z STATISTIC

	MALE	FEMALE
SLP - EDINA	.0786	[illegible]
SLP - RICH	.2256	[illegible]*
EDINA-RICH	.1454	[illegible]

STANDARD MORBIDITY RATIOS

	MALE	FEMALE
S L PARK	[illegible]	[illegible]
EDINA	0	1.11
RICHFIELD	0	[illegible]

AVERAGE ANNUAL AGE ADJUSTED INCIDENCE RATES/100000 1969-71

	MALE	FEMALE
S L PARK	1.16	[illegible]
EDINA	0	[illegible]
RICHFIELD	0	[illegible]

CHI-SQUARE VALUES FOR COMPARISON CITIES

COMPARISON		MALE	FEMALE	AGE-SEX ADJ
S L PARK -	EDINA	.00	[illegible]	1.67
S L PARK -	RICHFIELD	.00	[illegible]**	11.35**
S L PARK -	SMSA	[illegible]	[illegible]**	14.20**
EDINA -	RICHFIELD	0	[illegible]	[illegible]
EDINA -	SMSA	[illegible]	[illegible]	[illegible]
RICHFIELD -	SMSA	[illegible]	[illegible]	1.04

SITE = 74

Breast Cancer

001584

56

DIGESTIVE SYSTEM

SITE = 5

THREE YEAR TOTAL NUMBER OF CASES - 1969-71

	MALE				FEMALE			
	S L PARK	EDINA	RICHFIELD	SMSA	S L PARK	EDINA	RICHFIELD	SMSA
LT 15	1.00	0	0	6.00	0	0	0	2.00
15-24	1.00	0	0	5.00	0	0	0	2.00
25-34	0	0	0	16.00	1.00	2.00	0	19.00
35-44	1.00	2.00	1.00	66.00	2.00	1.00	1.00	46.00
45-54	7.00	6.00	[illegible]	194.00	2.00	5.00	1.00	134.00
55-64	15.00	15.00	[illegible]	473.00	12.00	6.00	8.00	376.00
65-74	14.00	14.00	7.00	577.00	22.00	7.00	6.00	509.00
75-84	10.00	13.00	[illegible]	541.00	23.00	7.00	5.00	561.00
85 +	2.00	1.00	4.00	144.00	5.00	0	4.00	208.00
ALL AGES	[illegible]	51.00	[illegible]	2022.00	57.00	28.00	25.00	1877.00

AVE AGE ANNUAL INCIDENCE RATES/100000 1969-1971

	MALE				FEMALE			
	S L PARK	EDINA	RICHFIELD	SMSA	S L PARK	EDINA	RICHFIELD	SMSA
LT 15	[illegible]	0	[illegible]	.73	0	0	0	.25
15-24	[illegible]	0	0	1.13	0	0	0	.39
25-34	0	0	[illegible]	4.37	9.17	28.67	0	5.15
35-44	13.46	[illegible]	[illegible]	23.04	24.44	10.21	12.40	15.94
45-54	[illegible]	61.65	[illegible]	74.26	20.44	50.41	10.29	48.52
55-64	[illegible]	[illegible]	177.43	253.21	160.64	92.25	149.81	173.69
65-74	415.18	462.05	[illegible]	514.30	469.48	185.19	214.36	310.05
75-84	[illegible]	1064.70	[illegible]	940.52	996.97	374.53	333.33	601.54
85 +	[illegible]	[illegible]	[illegible]	1176.18	1028.81	0	1084.01	832.53
ALL RATES	[illegible]	[illegible]	[illegible]	79.34	87.84	41.50	34.37	68.44

Z STATISTIC

	MALE	FEMALE
SLP - EDINA	[illegible]	[illegible]
SLP - RICH	[illegible]	[illegible]
EDINA-RICH	[illegible]	[illegible]

STANDARD MORBIDITY RATIOS

	MALE	FEMALE
ST L PARK	[illegible]	[illegible]
EDINA	[illegible]	[illegible]
RICHFIELD	.90	[illegible]

AVERAGE ANNUAL SEX ADJUSTED INCIDENCE RATES/100000 1979-71

	MALE	FEMALE
ST L PARK	[illegible]	[illegible]
EDINA	[illegible]	[illegible]
RICHFIELD	[illegible]	[illegible]

[illegible] VALUES FOR COMPARISON CITIES

COMPARISON	MALE	FEMALE	AGE-SEX ADJ
S L PARK - EDINA	[illegible]	[illegible]	[illegible]
S L PARK - RICHFIELD	.01	[illegible]	[illegible]
S L PARK - SMSA	[illegible]	[illegible]	[illegible]
EDINA - RICHFIELD	.00	.01	.00
EDINA - SMSA	[illegible]	[illegible]	[illegible]
RICHFIELD - SMSA	[illegible]	[illegible]	[illegible]

SITE = 5

001585

Diaestive System Cancer

COLON, EXC. RECTUM

SITE = 53

THREE YEAR TOTAL NUMBER OF CASES 1969-71

	MALE S L PARK	MALE EDINA	MALE RICHFIELD	MALE SMSA	FEMALE S L PARK	FEMALE EDINA	FEMALE RICHFIELD	FEMALE SMSA
LT 15	0	0	0	0	0	0	0	0
15-24	0	0	0	1.00	0	0	0	0
25-34	0	0	0	9.00	1.00	2.00	0	13.00
35-44	1.00	0	0	26.00	0	1.00	0	22.00
45-54	2.00	2.00	3.00	58.00	0	1.00	1.00	57.00
55-64	5.00	3.00	2.00	173.00	7.00	2.00	5.00	190.00
65-74	6.00	8.00	3.00	212.00	15.00	3.00	5.00	245.00
75-84	6.00	3.00	9.00	230.00	11.00	3.00	3.00	277.00
85 +	1.00	0	1.00	51.00	2.00	0	4.00	103.00
ALL AGES	21.00	16.00	18.00	760.00	36.00	12.00	18.00	907.00

AVERAGE ANNUAL INCIDENCE RATES/100000 1969-1971

	MALE S L PARK	MALE EDINA	MALE RICHFIELD	MALE SMSA	FEMALE S L PARK	FEMALE EDINA	FEMALE RICHFIELD	FEMALE SMSA
LT 15	0	0	0	0	0	0	0	0
15-24	0	0	0	.23	0	0	0	0
25-34	0	0	0	2.46	9.17	28.67	0	3.52
35-44	13.46	0	0	9.08	0	10.21	0	7.62
45-54	22.73	20.55	33.42	22.20	0	10.08	10.29	20.64
55-64	78.39	51.18	39.52	92.61	93.71	30.75	93.63	87.77
65-74	177.94	264.03	145.99	188.99	320.10	79.37	178.64	169.24
75-84	423.73	245.70	1023.89	403.25	476.81	160.51	200.00	286.79
85 +	378.79	0	724.64	416.56	411.52	0	1084.01	412.26
ALL AGES	30.33	24.91	26.46	29.82	47.20	17.78	24.75	33.07

Z STATISTIC

	MALE	FEMALE
SLP - EDINA	.3563	2.8584#
SLP - RICH	.9440	1.0078
EDINA-RICH	1.2272	1.5983

STANDARD MORBIDITY RATIOS

	MALE	FEMALE
ST L PARK	.95	1.43
EDINA	.80	.56
RICHFIELD	1.15	1.02

AVERAGE ANNUAL AGE ADJUSTED INCIDENCE RATES/100000 1969-71

	MALE	FEMALE
ST L PARK	28.72	48.13
EDINA	22.98	18.78
RICHFIELD	39.14	30.04

CHI-SQUARE VALUES FOR COMPARISON CITIES

COMPARISON	MALE	FEMALE	AGE-SEX ADJ
S L PARK - EDINA	.16	7.10**	5.64**
S L PARK - RICHFIELD	.20	.74	.05
S L PARK - SMSA	.01	4.09**	1.79
EDINA - RICHFIELD	1.04	1.95	3.34
EDINA - SMSA	.64	1.74	4.10**
RICHFIELD - SMSA	.23	.00	.15

SITE = 53

Colon, exc. rectum

RESPIRATORY SYSTEM

SITE = 6

THREE YEAR TOTAL NUMBER OF CASES 1969-71

	MALE				FEMALE			
	S L PARK	EDINA	RICHFIELD	SMSA	S L PARK	EDINA	RICHFIELD	SMSA
LT 15	0	0	0	0	0	0	0	4.00
15-24	0	0	0	0	0	0	0	0
25-34	0	0	0	7.00	0	0	0	3.00
35-44	2.00	1.00	1.00	46.00	0	2.00	0	17.00
45-54	[illegible]	3.00	[illegible]	213.00	5.00	3.00	4.00	73.00
55-64	17.00	10.00	7.00	446.00	4.00	1.00	2.00	102.00
65-74	10.00	11.00	7.00	438.00	5.00	2.00	0	100.00
75-84	[illegible]	9.00	3.00	247.00	3.00	1.00	0	49.00
85 +	1.00	2.00	0	30.00	1.00	0	0	16.00
ALL AGES	[illegible]	36.00	26.00	1427.00	18.00	9.00	6.00	364.00

AVERAGE ANNUAL INCIDENCE RATES/100000 1969-1971

	S L PARK	EDINA	RICHFIELD	SMSA	S L PARK	EDINA	RICHFIELD	SMSA
LT 15	0	0	0	0	0	0	0	.51
15-24	0	0	0	0	0	0	0	0
25-34	0	0	0	1.91	0	0	0	.81
35-44	[illegible]	11.17	[illegible]	16.06	0	20.41	0	5.89
45-54	[illegible]	30.83	[illegible]	81.54	51.11	30.25	41.18	26.43
55-64	[illegible]	170.59	177.43	238.75	53.55	15.38	37.45	47.12
65-74	[illegible]	363.04	390.63	390.47	106.70	52.91	0	60.91
75-84	[illegible]	737.10	[illegible]	433.06	130.04	53.50	0	50.73
85 +	[illegible]	925.93	0	245.04	205.76	0	0	64.04
ALL AGES	[illegible]	56.04	[illegible]	55.99	23.60	13.34	8.25	13.27

Z STATISTIC

	MALE	FEMALE
STP - EDINA	.3026	1.3080
STP - RICH	[illegible]	1.6147
EDINA-RICH	.6632	[illegible]

STANDARD MORBIDITY RATIOS

	MALE	FEMALE
ST L PARK	.91	[illegible]
EDINA	.80	[illegible]
RICHFIELD	.79	[illegible]

AVERAGE ANNUAL AGE ADJUSTED INCIDENCE RATES/100000 1969-71

	MALE	FEMALE
S L PARK	50.74	[illegible]
EDINA	53.84	[illegible]
RICHFIELD	[illegible]	7.19

PROB OF Z VALUES FOR COMPARISON CITIES

COMPARISON	MALE	FEMALE	AGE-SEX ADJ
S L PARK - [illegible]	[illegible]	[illegible]	.01
S L PARK - RICHFIELD	[illegible]	[illegible]	1.92
S L PARK - [illegible]	[illegible]	[illegible]	.12
EDINA - RICHFIELD	.92	[illegible]	.14
EDINA - [illegible]	[illegible]	.02	.54
RICHFIELD - [illegible]	[illegible]	[illegible]	1.89

SITE = 6

Respiratory System Cancer

001587

NG, BRONCHUS, TRACHEA

SITE = 62

THREE YEAR TOTAL NUMBER OF CASES 1969-71

	MALE				FEMALE			
	S L PARK	EDINA	RICHFIELD	SMSA	S L PARK	EDINA	RICHFIELD	SMSA
LT 15	0	0	0	0	0	0	0	0
15-24	0	0	0	0	0	0	0	0
25-34	0	0	0	7.00	0	0	0	2.00
35-44	2.00	1.00	1.00	38.00	0	2.00	0	15.00
45-54	4.00	3.00	6.00	178.00	4.00	1.00	2.00	63.00
55-64	15.00	10.00	9.00	380.00	4.00	0	2.00	92.00
65-74	10.00	8.00	6.00	393.00	4.00	2.00	0	91.00
75-84	4.00	9.00	3.00	226.00	3.00	1.00	0	43.00
85 +	0	1.00	0	24.00	1.00	0	0	14.00
ALL AGES	35.00	32.00	25.00	1246.00	16.00	6.00	4.00	320.00

AVERAGE ANNUAL INCIDENCE RATES/100000 1969-1971

	MALE				FEMALE			
	S L PARK	EDINA	RICHFIELD	SMSA	S L PARK	EDINA	RICHFIELD	SMSA
LT 15	0	0	0	0	0	0	0	0
15-24	0	0	0	0	0	0	0	0
25-34	0	0	0	1.91	0	0	0	.54
35-44	26.91	11.17	13.83	13.26	0	20.41	0	5.20
45-54	45.46	30.83	66.84	68.14	40.89	10.08	20.59	22.81
55-64	235.18	170.59	177.83	203.42	53.55	0	37.45	42.50
65-74	246.56	264.03	241.97	350.35	85.36	52.91	0	55.43
75-84	282.49	737.10	301.30	396.24	130.04	53.50	0	44.52
85 +	0	462.96	0	196.03	205.76	0	0	56.04
ALL AGES	50.54	49.82	16.74	48.89	20.98	8.89	5.50	11.67

Z STATISTIC

	MALE	FEMALE
SLP - EDINA	.2330	1.4234
SLP - RICH	.1368	1.6608
EDINA-RICH	.3456	.2336

STANDARD MORBIDITY RATIOS

	MALE	FEMALE
ST L PARK	.92	1.13
EDINA	.90	[illegible]
RICHFIELD	.88	[illegible]

AVERAGE ANNUAL AGE ADJUSTED INCIDENCE RATES/100000 1969-71

	MALE	FEMALE
ST L PARK	44.30	17.41
EDINA	47.26	[illegible]
RICHFIELD	41.93	[illegible]

CHI-SQUARE VALUES FOR COMPARISON CITIES

COMPARISON	MALE	FEMALE	AGE-SEX ADJ
S L PARK - EDINA	.00	2.80	.80
S L PARK - RICHFIELD	.01	1.46	1.24
S L PARK - SMSA	.17	1.18	.14
EDINA - RICHFIELD	.01	.00	.00
EDINA - SMSA	.27	.35	.77
RICHFIELD - SMSA	.32	1.12	1.13

SITE = 62

Lung, Bronchus, Trachea Cancer

Dusick report on Epidemiological Investigation... (1975)
I will have rest mailed to you
SS

Appendix C. General Information on Water Supply Systems

References:

1. Manual of Individual Water Supply Systems. U.S. EPA, Water Supply Division, 1974.

2. Water Resources Outlook for the Minneapolis-St.Paul Metropolitan Area, Minnesota. Prepared by USGS in cooperation with Metropolitan Council, 1974.

3. Water Resources: Policy Plan, Program. Metropolitan Council, W/12/73, 1973.

001589

Source of Water

The source of all water available for domestic and other uses is precipitation by means of a cycle known as the hydrologic cycle -- the circuit of water movement from the atmosphere to the earth and returned to the atmosphere through processes such as precipitation, runoff, infiltration, percolation, storage, evaporation and transpiration. The hydrologic cycle is depicted in Figure C-1.

Water resources occur in the Minneapolis - St. Paul metropolitan area as ground water and surface water (Figure C-2). Precipitation that infiltrates into the soil acts to recharge the ground water supply. Ground water is water contained in the zone of saturation lying immediately below the water table where all pore spaces and voids in the rocks are filled with water at a pressure equal to atmospheric pressure (water table conditions) or greater than atmospheric pressure (artesian conditions). In the twin cities most aquifer water below the St. Peter is under artesian pressure and artesian conditions prevail in the St. Peter where it is fully saturated and over lain by Glenwood shale.

Precipitation that does not infiltrate the ground or evaporate flows over the ground surface and is classified as direct runoff. Where this runoff collects in natural reservoirs (rivers and lakes) or artificial reservoirs (cisterns it becomes surface water.

Although the ultimate supply of both ground water and surface water is precipitation, in some parts of the metropolitan area groundwater is recharged by surface water (where the aquifers are exposed in stream channels), while in other parts ground water is discharged to surface water (at springs or at intersections of a water body and a water table).

Geology

001590

The abundant ground water resources in the metropolitan area result from the Twin Cities artesian basin located within the Southeastern [illegible] Province, and made up of Precambrian, Cambrian and Ordovician [illegible] youngest [illegible] formations. At one time the entire Minneapolis - St. Paul metropolitan area was glaciated, thus the present land surface is largely composed of drift with its configuration attributable to glacial and post-glacial deposition.

The bedrock surface is dissected by deep valleys and tunnelling streams. These valleys are significant to the hydraulic continuity between the bedrock formations and the glacial drift.

The rock formations beneath the surface in the Twin Cities artesian basin are as wide in variety and as hydrologically complex as any other sequence of rocks in the country. A description of the bedrock units, their position in the geologic column, and their water-bearing characteristics is shown in Figure C-3. The bedrock sequence, as I have already stated is very complex, but in general can be divided into 5 aquifers and 5 aquitards. An aquifer is a geologic formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs. In order of use and development the major bedrock aquifers are: 1. Prairie du Chien-Jordan, 2. Mt. Simon-Hinckley, 3. Ironton-Galesville, 4. St. Peter, and 5. Platteville. The Prairie du Chien-Jordan and the Mt. Simon-Hinckley consolidated aquifers are among the most productive in the U.S. and are the source of 90% of the ground water for the 7 county metropolitan area. They cover 2,000 and 6,000 square miles respectively(Figure C-4).

The first three of the six aquifers noted are considered single hydrologic units because of the extensive movement of water between the two geologic units. For example, recharge to the Jordan sandstone is mainly through the Prairie du Chien group,therefore wells tapping these rocks are most often completed in the Jordan sandstone to benefit from the yield of both units.

An aquitard is a confining bed made of materials that are semi-[illegible]. The 5 aquitards of the Twin Cities artesian basin are in descending order: 1. The Glenwood shale beneath the Platteville aquifer, 2. The siltstone or shale at the bottom of the St. Peter aquifer, 3. The dolomitic siltstone and dolomitic sandstone of the St. Lawrence formation beneath the Jordan sandstone, 4. The fine grained sandstone of the Franconia formation, and 5. The Eau Claire sandstone.

Within the zone of saturation the position and type of individual units controls the water yield: aquifers yield much more water than aquitards which yield more water than aquicludes which are essentially impermeable.

Ground Water Principles of Occurrence

Ground water is stored in and moving through the rocks shown in Figure C-3. The ability of rocks to store and transmit water is dependent upon the interconnection of pores by interstices. Aquifers have either one or both of two kinds of permeability - primary intergranular or secondary solution cavity and fracture. Examples of aquifer materials having the different kinds of permeability are depicted in Figure C-5.

The sand and gravel aquifers in the glacial drift have the former and the Mt. Simon-Hinckley, Galesville, Ironton, Jordan, and St. Peter sandstones can have both as they are variously cemented in part. The Prairie du Chien and Platteville limestone and dolomite have the latter. The type of permeability significantly controls the filtering capabilities of a rock. For example, organic liquid wastes, such as effluent from septic tanks, discharged through rocks with primary permeability. Also, permeability type often affects the hydraulic properties of a rock. Rocks with primary permeability are likely to have homogeneous hydraulic properties; whereas rocks with secondary permeability will have heterogeneous properties for which there are no mathematical ground water-flow analyses available.

Ground Water Movement

Ground water is constantly in motion, moving from places of high potential to places of low potential and from areas of recharge to areas of discharge. The rate of movement is slow. The direction of movement is approximately perpendicular to lines of equal head. The potential at any one place in a given aquifer is represented by the static water level (above mean sea level) in a well completed at that place in that aquifer.

A map of the potentiometric surface of the water in an aquifer is made by contouring head differences that are measured in several wells completed in the aquifer. Because water levels flucuate to some extent both seasonally (decrease in summer due to air conditioning and watering lawns; increase in winter due to some wells being shut down) and annually (downward trend indicating increased rates of pumping), these surfaces are only representative of the period of time dipicted. Nevertheless these maps are useful in showing the generalized direction of overall lateral ground water flow in the aquifers.

Water in the Prairie du Chien-Jordan aquifer flows away from three highs in its potentiometric surface - one in the White Bear/Forest Lake area in the northeast; another in the Minnetonka area in the west; and third in the Vermillion River headwater area in the south. Regional flow from these highs is towards the three major streams, hence downstream to the southeast. (Minnesota River flows northeastward; St. Croix River flows southward; Mississippi River flows southeastward).

Local flow patterns, however, are extremely complex due to the highly developed well system of the metro area which has changed both the direction and the rate of ground water flow.

Water level maps show that water is moving in parts of the bedrock towards pumping centers instead of towards streams and lakes which is the natural hydraulic gradient. Dams on the Mississippi River above the mouth of the Minnesota River also affect local directions of ground water flow.

Generally water moves vertically from overlying to underlying aquifers, but moves upward where the potentiometric differences allow. Flow may reverse locally in the vicinity of pumping wells, generally the reversal is short-lived, but if it becomes perenial much of the water discharged from the pumping wells may be supplied by lower aquifers.

001593

Ground Water Production

Wells are used to extract water from the ground water reservoir. [illegible] wells are classified as by their method of construction, they [illegible], bored, drilled, or driven. Drilling is the method most commonly used and if properly constructed deep drilled wells will normally provide excellent protection against contamination.

When a well is used to pump water from a water-bearing aquifer, it has the effect of draining an inverted cone shaped area of the aquifer called the cone of depression (the apex of the cone is at the well). The water level in a well that is not being pumped is called the static water level. If the well is an artesian well, the static level will be above the aquifer at the well location. This level is independent of the water table, and is called the hydrostatic or potentiometric surface.

The drawdown of a well is the difference between the static level and the pumping level. At increasing distances from the well the drawdown decreases until the slope of the cone merges with the static water table. The radius of influence is the distance from the well at which this occurs. The radius continually expands as greater amounts of water are withdrawn. If 2 wells are close enough so that their circles of influence overlap, then mutual interference occurs and the production of both wells is decreased. Wells completed in water table aquifers (unconfined) can be closer together without mutual interference than wells completed in artesian aquifers (confined). This is because the diffu sivity, which is a measure of the spread of the effects of pumping, is much less (slower) in the former than in the latter. Pumping effects on aquifers is shown in Figure C-6.

<u>Ground Water Quality</u>

001594

The U.S. EPA provides minimum standards for water quality. Chemical characteristics are measured and reported on the basis of weight of substance per unit volume of water, for example ppm and ppb (1 ppm of a chemical in water means that for every 1 million gallons of water (8,340,000 lbs), 8.34 lb. of chemical are present). In water, 1ppm = 1mg/l and 1ppb = 1µg/l.

Water quality variables include pathogenic organisms, turbidity (suspended particles in water), total dissoved solids (measure of nonsettleable and non-filterable solids in solution), tastes and odors, color, hardness (caused by the presence of calcium and magnesium salts in solution), and pH (relative acidity of alkalinity of water).

Unlike surface water, ground water quality is normally constant over long periods of time. (The quality of river water may vary from day to day). The quality of the ground water supply for the metro area is generally good. However, there has been contamination of the ground water aquifers due to septic tank and cesspool discharges, industrial plant discharges and improper on-lot disposal of liquid and solid wastes. This contamination has been confined mainly to the unconsolidated aquifers (drift) and the uppermost bedrock aquifers, but with time contamination of the surface water and of water in the glacial drift can affect the quality of water in the underlying consolidated aquifers.

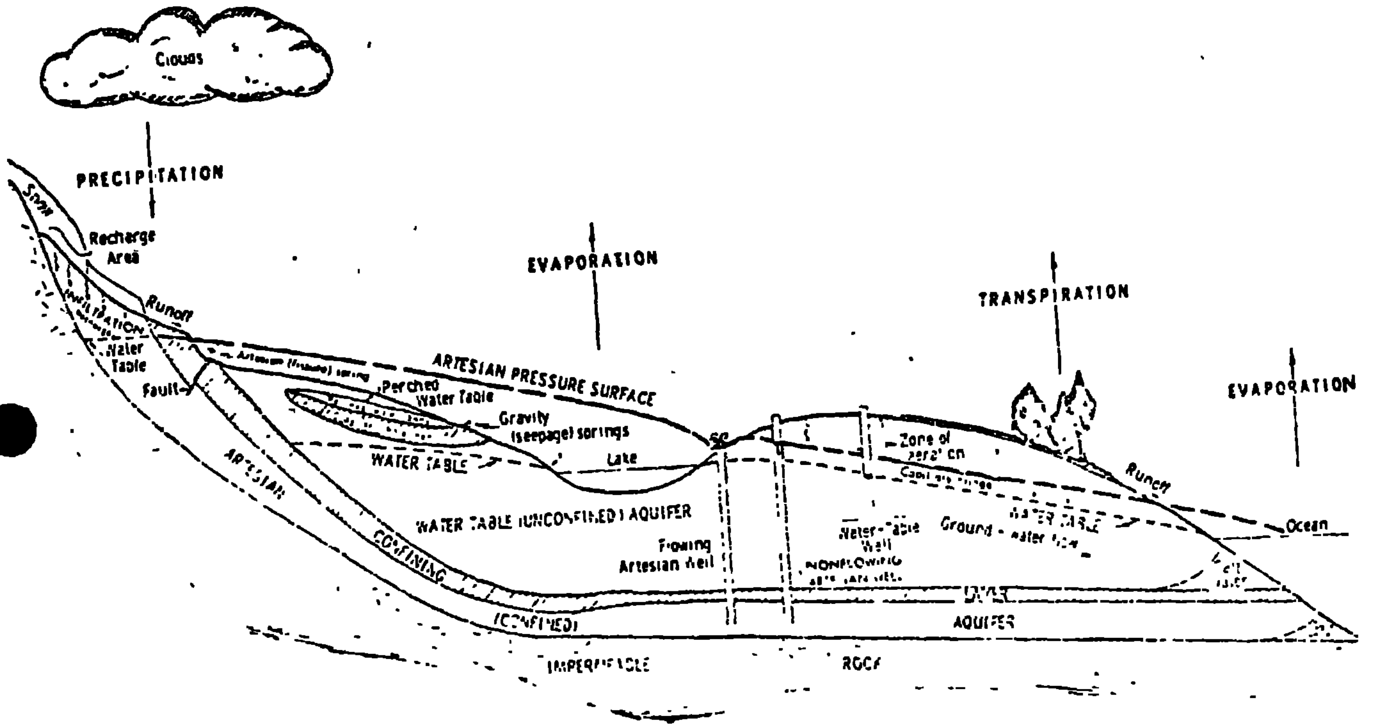

Figure C-1 **The hydrologic cycle**

Borrowed from Manual of Individual Water Supply Systems, U.S. Environmental Protection Agency, Office of Water Programs, Water Supply Division, 1974.

001596

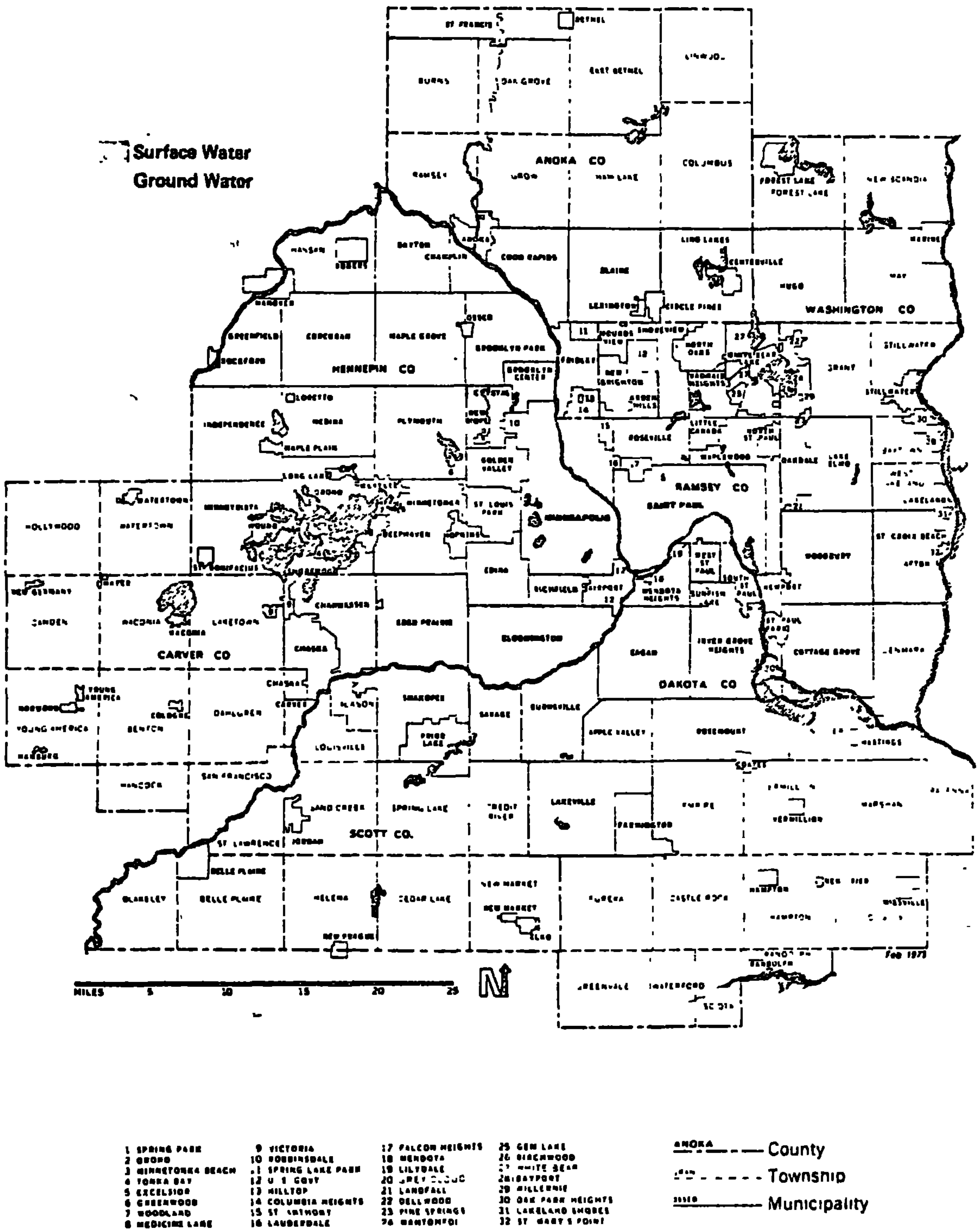

Figure C-2

Areas served by municipal water supplies, either partially or totally, 1973. (Borrowed from Water Resources, 1973)

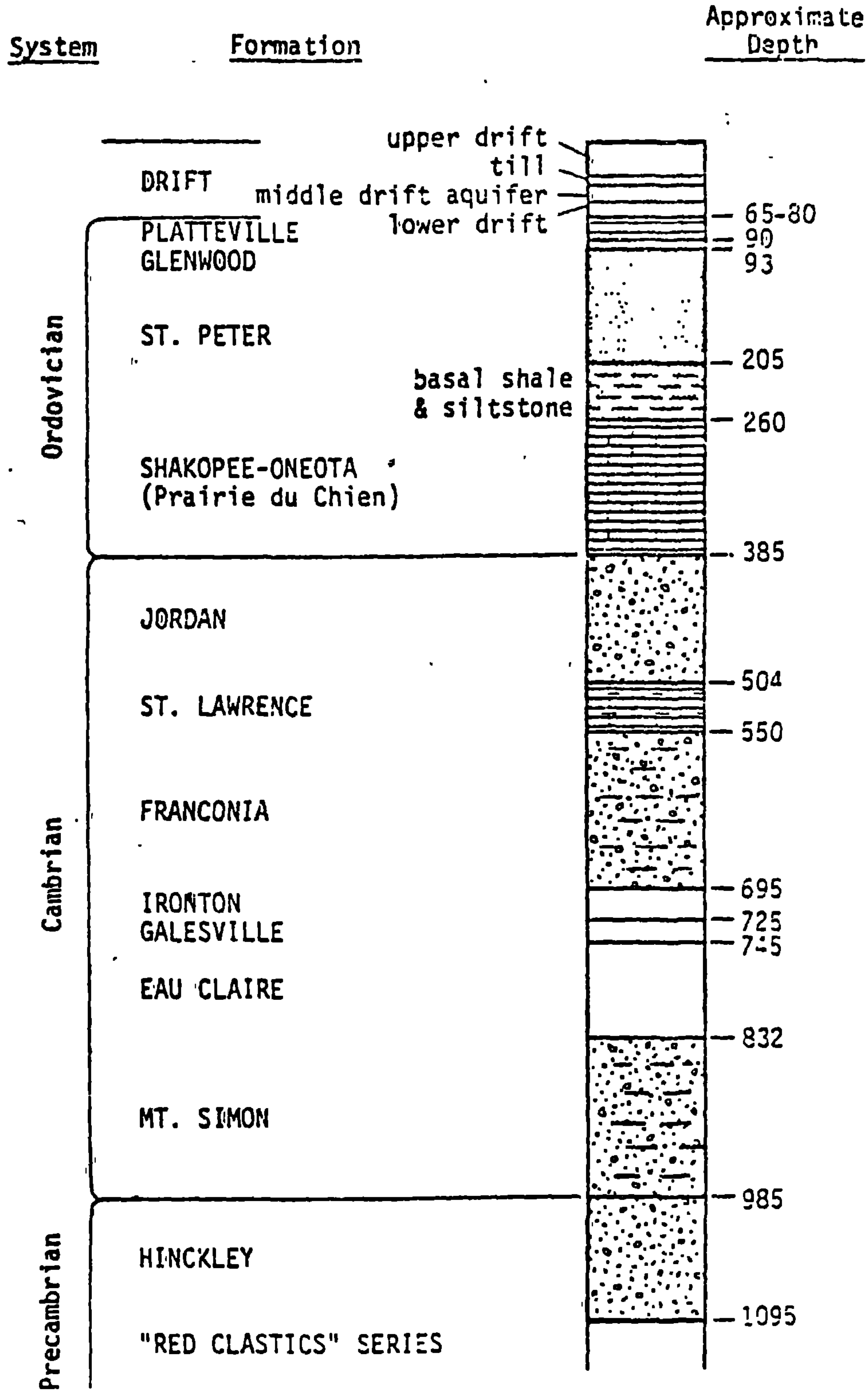

Figure C-3 **Generalized Geologic Column**

Borrowed from Barr Phase II Report (adopted from Sunde, Hydrogeologic Study of the Republic Creosote Site, 1974)

001598

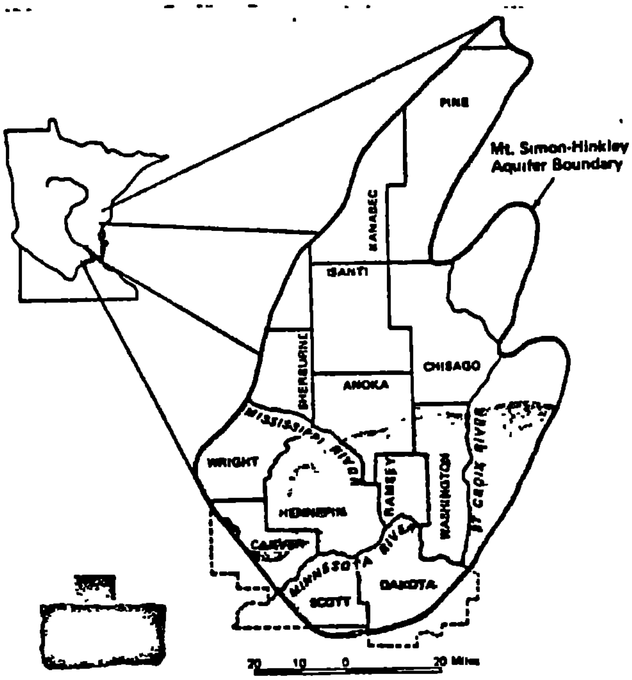

Figure C-4. **Major ground water aquifers available to the Metropolitan area.**

Borrowed from Water resource, 1973.

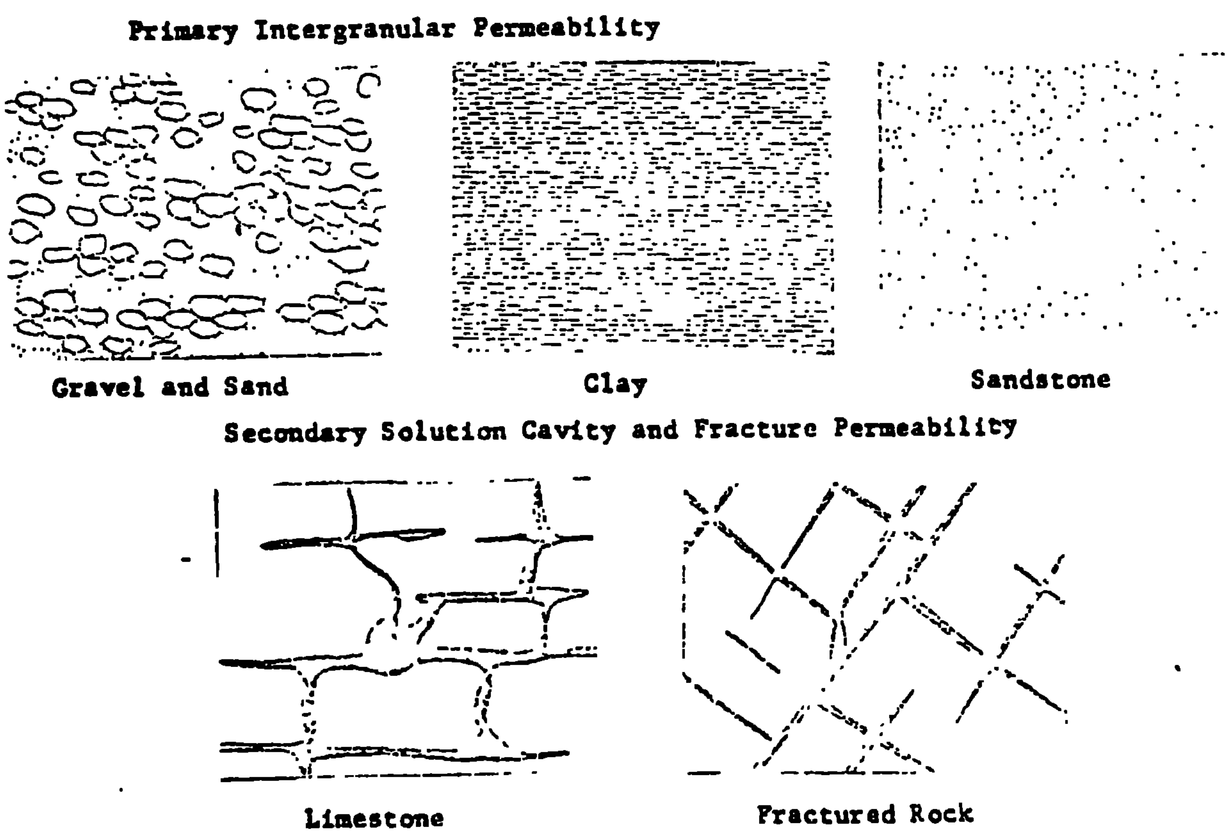

Figure C-5. **Aquifer materials having primary and secondary permeabilities**

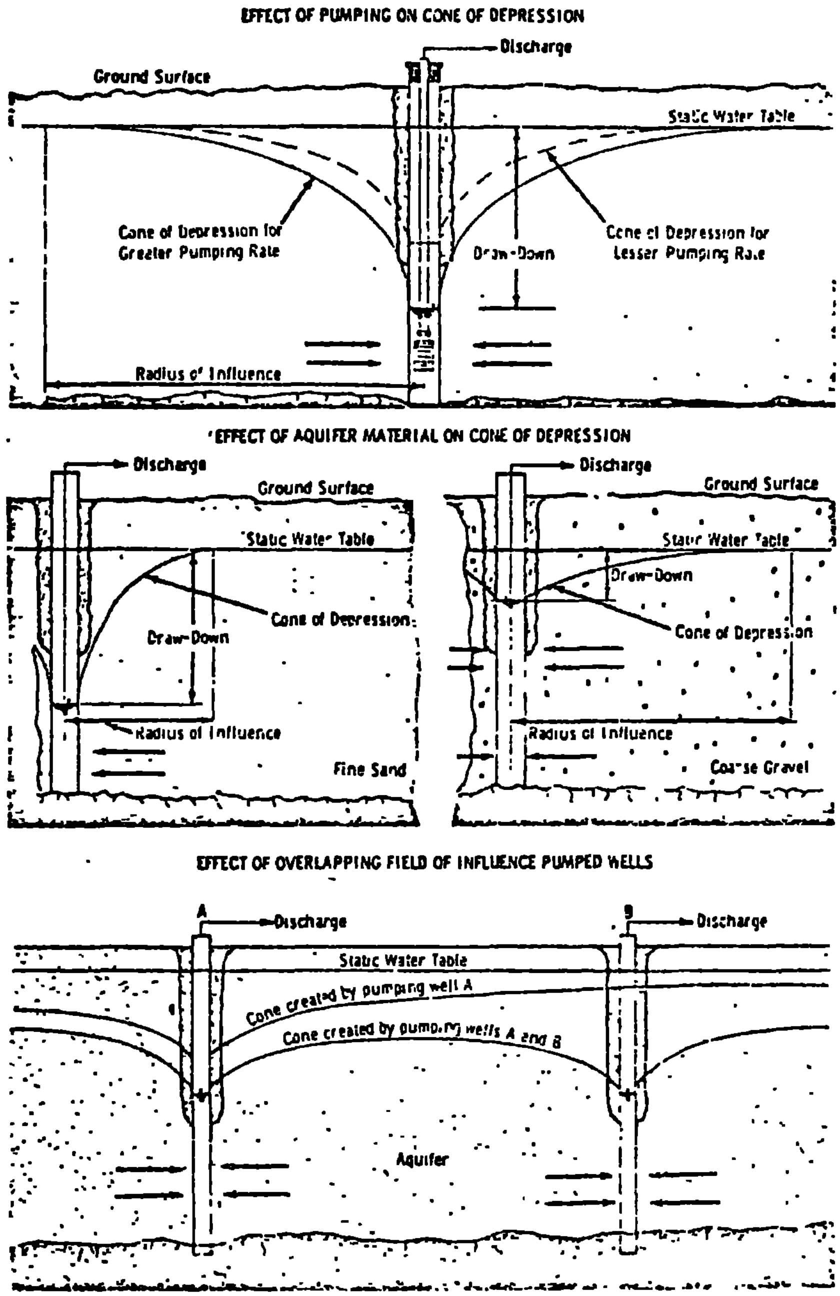

Figure C-6. **Pumping effects on aquifers.**

Borrowed from **Manual of Individual Water Supply Systems, 1974.**

001600

Appendix D. St.Louis Park Water Supply System

St. Louis Park began construction on its first 2 watermains in 1929. The first was 128,000 feet of 6", 8", and 12" watermain connected to the Minneapolis Water Supply mains at France Avenue and Minnetonka Boulevard. (serviced the Sunset Gables area of St. Louis Park). The second watermain was connected to the Minneapolis main at 38th Street and France Avenue (serviced area of Excelsior Boulevard from France Avenue to Wooddale Avenue).

In 1931 the Village of St. Louis Park was notified by the City of Minneapolis that they should start making arrangements to construct an elevated tower and drill a well to furnish their own water supply.

"Old City well # 1" was drilled in May, 1932. According to Maynard Kays, Superintendent of the Water and Sewer Department, "Old City well # 1" located at 36th and Brunswick went into operation in July 1934, but was closed in August, 1934 due to the strong odor and bad taste of the water. (USGS reports that "Old City well # 1 was abandoned in 1933).

In 1938 the city made their final break from Minneapolis water services when they put into operation wells # 2 and 3 located near 29th and Idaho. From 1938 - 1941 these 2 wells supplied the water needs for the city.

There was an expansion period from 1941 - 1960 in which additional wells, mains, and pumping equipment were constructed.

The city had many problems of dead-end mains (must be flushed frequently or will service poor quality water) and high iron content in the water causing rusty water problems.

In 1964 the first central consol was installed in the City Hall so that the city could operate all of its plants and pumping stations from one central location.

By the end of 1974 the city had: 1. 16 deep wells with a combined capacity of 26,000,000 gallons a day, 2. 4 elevated towers with a combined capacity of 2.6 million gallons, 3. 4 ground storage reservoirs with a combined capacity of 5 million gallons, and 4. several iron removal plants. (see Tables [illegible]

001601

Source: [illegible]

It is not known how long PAH compounds have been in the St.Louis Park water supply as instruments and techniques for their detection in water have become available only recently. It is possible, however, that they have been there for a long time.

St.Louis Park's first well was drilled in 1932 (well bore open to the Prairie du Chien-Jordan aquifer) and shut down a few months later due to the creosote taste and odor of the water. Furthermore, a company well drilled in 1917 and open to the Hinckley aquifer has long been both a source of contamination due to a spill directly into the well and a pathway of contamination due to a leak in its casing.

In 1930 the population of St.Louis Park was 4,710 and these residents obtained their drinking water either from the Minneapolis Water Supply System or from private wells. By 1940 the population had grown to 7,737 residents who were serviced by two St.Louis Park municipal wells in addition to privately owned wells. The population increased to 22,644 in 1950, a 193 percent increase from the preceding census. By 1960 the population was 43,310 and was serviced primarily by eleven St.Louis Park municipal wells. A few residents along France Avenue still received Minneapolis water.

The size of Edina's population was about comparable to St.Louis Park's until after 1940 when St.Louis Park increased in size much more rapidly than Edina. Richfield, on the other hand, started out more slowly, but by 1950 had almost reached the size of St.Louis Park and continued to be comparable in population size thereafter. The percent of housing units built in each community between census years follows the pattern of population growth. (See [illegible]

Population size is of interest in terms of such factors as population density, degree of urbanization and level of industrialization. The years in which the housing units were built could be significant in terms of the age of the water supply systems and the types of materials used and their construction (eg. water-mains, pumps, valves, etc.).

001602

TABLE D-1

St. Louis Park Municipal Water Supply Stations

Station #	Location	Well #	High Service Pump	Elevated Tower Capacity	Underground Reservoir Capacity
1	2936 Idaho Avenue	1,2,3, 10,11,15	1,2,12 (1970)	--	1.5 x 10^6 gal. (1946)
3	36th & Brunswick	--	--	100,000 Gal. (1932)	--
4	4701 W. 41st St.	4	3 (1946) Removed 1973	--	--
5	8301 W. 34th St.	5	4 (1947)	1 x 10^6 Gal (1950)	15,000 Gal.
6	4241 Cartham Ave.	6, 12	5,6 (1964) 7 (1948)	--	1.5 x 10^6 Gal. (1963)
7	2500 Louisiana Ave.	7,9	8 (1956)	1 x 10^6 Gal. (1952)	30,000 Gal.
8	9701 W. 16th St.	8	--	--	--
9	5264 Excelsior Blvd.	--	--	500,000 Gal. (1941)	--
10	5005 Cedar Lk. Rd.	13,14	9,10,11 (1964)	--	2 x 10^6 Gal. (1964)
16	8004 Elmo Avenue (Iron removal plant-1974)	16	13,14, 15,16	--	1.5 x 10^6 Gal. (1974)

Source: City of St. Louis Park Water Dept.

001603

Table D-

St. Louis Park Municipal Wells in Use and Abandoned*

001604

Well #	Identifier/Location	Driller	Date Drilled	Driller's Log	Originally Reported Depth of Well in Ft.	Measured Depth of Well in Ft.	Casing Schedule	Aquifers Open to Well Bore	Water Level in Ft. and Date Measured	Remarks
Old 1 (USGS-W112)	36th & Brunswick	McCarthy Well Co.	05-28-32	0-109 Qd 109-274 Osp 274-398 Opc 398-486 Cj 486-540 Csl	540	421 in 1953 340 in 1978	16" 0-212 12" 194-274	Opc-Csl 1932 Opc-? 1978	77 12-21-78	Abandoned in 1933 because of creosote taste. It has been a USGS water level monitoring well since 1953.
1 & (Draw from Osp)	29th and Idaho	Max Renner	1938	0-104 Qd 104-136 Opl 136-290 Osp	290	--	16" 0-104	--	--	Abandoned and filled with cement on 4/25/78.
3 (USGS-W113)	29th and Idaho	McCarthy Well Co.	1939	0-103 Qd 103-118 Opl 118-286 Osp	286	--	24" 0-103	Opl-Osp	60 08-39	Stand-by well used fr backwash of iron filter plant
4	41st and Natchez	Layne-Western	1946	--	503	--	24" 18" 415	--	--	Grouted in 1962 to 420 feet. Closed 1979
5	34th and Wyoming	Layne-MN	1947	--	465	--	24" 20" 305	--	--	Grouted through the St. Peter ≈ 305 feet.
6	42nd and Zarthan	Layne-MN	1948	--	480	--	24" 20" 430	--	--	
7	[illegible]	Layne-MN	195[illegible]	--	446	--	24" 20" 247	--	--	Closed November, 1979.
8	16th and Kilmer	Bergerson-Caswell	1956	--	507	--	24" 16" 314	--	--	
9	[illegible]	Bergerson-Caswell	1956	-	473	--	24" 16" 289	--	--	Closed November, 1978

001605

Table D-2

St. Louis Park Municipal Wells in Use and Abandoned*

Well #	Identifier/Location	Driller	Date Drilled	Driller's Log	Originally Reported Depth of Well in Ft.	Measured Depth of Well in Ft.	Casing Schedule	Aquifers Open to Well Bore	Water Level in Ft. and Date Measured	Remarks
10	29th and Idaho	Keys Well Company	1956	0 - 105 Qd 105 - 125 Opl 125 - 290 Osp 290 - 409 Ojc 409 - 500 Cj	500		24" 16" 315			Closed November, 1978
11	29th and Idaho	Bergerson-Caswell	1960		1093		24" 16" 880			
12	42nd and Zarthan	Keys Well Company	1963		1095		24" 16" 900			
13	Alabama & Cedar Lake Road	Layne-MN	1964		1045		30" 24" 16" 891			
14	Alabama & Cedar Lake Road	Bergerson-Caswell	1965		485		30" 24" 16" 389			
15	29th and Idaho	Bergerson-Caswell	1969		480		30" 24" 398			Closed November, 1978.
16	Flag & Franklin		1973		500					

1→10 } drawn
11→16 } from
Ci

11-13 drawn from Ch

* Drillers log for wells # old 1 + 3 from USGS
# 1, 2 + 10 from Barr Phase II
Remaining data from Ver[illegible] Hilstrand, St Louis Park Water Superintend[illegible]

Table D-2 Continued

Driller's Log: (from USGS)

Qd	Glacial drift
Opl	Platteville Limestone
Ogl	Glenwood Shale
Osp	St. Peter Sandstone, undifferentiated
Ospu	St. Peter Sandstone, upper shale beds
Ospm	St. Peter Sandstone, middle beds
Ospl	St. Peter Sandstone, lower silty beds
Opc	Prairie du Chien Group
Cj	Jordan Sandstone
Csl	St. Lawrence Formation
Cf	Franconia Sandstone
Cig	Ironton and Galesville Sandstones
Cd	Eau Claire Sandstone
Cm	Mount Siron Sandstone
pCh	Hinckley Sandstone

Table D-3. Percent Housing Units by Year of Construction
Edina, Richfield, St.Louis Park and MSP SMSA

	Edina	Richfield	St. Louis Park	MSP SMSA*
No. all year housing units	13,299	14,986	16,033	574,826
% housing units built:				
1969-March 1970	5.4	1.7	2.1	4.8
1965-1968	17.1	12.3	8.0	11.1
1960-1964	17.9	15.3	15.3	13.0
1950-1959	37.6	45.1	37.6	22.0
1940-1949	10.6	20.8	26.4	9.9
1939 or earlier	11.4	4.8	10.7	39.1

* Minneapolis-St. Paul Standard Metropolitan Statistical Area

Source: 1970 Census of Population and Housing, Census Tracts, Minneapolis-St. Paul Standard Metropolitan Statistical Area, Minnesota, PHC(1)-132, March, 1972.

Table H-2 Structural, Equipment, and Financial Characteristics of Housing Units: 1970, pp. H-37, H-38.

Table D-4. Population by Census Year, Edina, Richfield,
St.Louis Park, 1920-1970.

	Edina	Richfield	St.Louis Park
1970	44,046	47,231	48,883
1960	28,501	42,523	43,310
1950	9,744	17,502	22,644
1940	5,855	3,779	7,737
1930	3,138	1,301	4,710
1920	1,833	------	2,281

Source: 1970 Census of Population, Number of INhabitants, Minnesota, PC(1)-A25 Minnesota, August, 1971.

Table 7 Population of Incorporated Places of 10,000 or More: 1900-1970, pp. 25-17, 25-18.

001607

Appendix E. St.Louis Park Water Contamination Problem (this section contains summaries of various reports)

Table E-1. Events and Reports in Chronological Order

Event or Report	Date
Sugar Plant Well # 1 drilled	1890 ±
Sugar Plant Well # 2 drilled	1908 ±
Creosote Plant Constructed Reilly Tar and Chemical Corp. & Republic Creosote Works	1917
St. Louis Park old city well # 1 drilled / shut down	1932/1933
Minnehaha Creek Water Shed District Report (Hickok)	1970 ← Mislabeled I think she means MPCA report on Reilly
MDH Letter	1970 Waste disposal (4/70) S.S.
St. Louis Park HUD purchases property	1973
Former Creosote Site land-farmed	1973
MDH Report	1974
Sunde Report	1974
Barr Phase I Report	1976
Biocentric Report	1976
Barr Phase II Report	1977
MDH Health Risk Assessment Report I	1977
St. Louis Park plugs wells # 1 & 2	March, 1978
MDH Health Risk Assessment Report II	November, 1978
St. Louis Park discontinues use of wells # 7,9,10 and 15	November, 1979

001608

Event or Report	Date
MDH Health Risk Assessment	July, 1978 - July, 1980
USGS Phase I, Geology & Hydrology	July, 1978 - July, 1979
USGS Phase II, Diffusion Dispersion Model	August, 1979 - August, 1980
USGS Final Report	October, 1980
Excavation	(August, 1979) - October, 1980
Treatment Methodology	(August, 1979) - October, 1980
Barrier Well Design	(August, 1979) - October, 1980
Well abandonment, MDH, private wells	July, 1978 - December, 1979
St. Louis Park well abandonment, city owned property	October, 1979 →
St. Louis Park Municipal Water Treatment Pilot Study	June, 1979 →
Request to Legislature and Congress for funding	November, 1980
Environmental Impact Statement	1982
Barrier Wells installed	1982
Water treatment system installed	1982 →
Barrier Wells pumped	1982 →
Contaminated well water treated	1982
Excavation and disposal of contaminated materials	1982
Request to Legislature and Congress for funding	1983, 1985, 1987, 1989, 1991
Ongoing monitoring and modeling	November, 1979 →

History St. Louis Park Versus Republic Creosote

The area under study is now known as Oak Park Village, owned by the Housing Authority of the City of St. Louis Park. The site was previously occupied by the Reilly Tar and Chemical Corporation and Republic Creosote Works, 1917 to 1972, engaged in the distillation of coal-tar products and creosote.

In 1969 the city adopted a comprehensive Air Pollution Ordinance and formed an Odor Panel to determine the extent of the air pollution nusiance from the Republic Creosote site. Then in 1970 the city of St. Louis Park and the Minnesota PCA initiated legal action to abate the air pollution. This was not settled until 1973 when the city purchased the site.

One of the major problems with Republic Creosote's operations was that all wastes were deposited on the land surface of the site, with concern that the run-off would seep into the ground and cause pollution of the ground water reservoirs below.

In April, 1970 the PCA staff prepared a report entitled "Minnehaha Creek Water Shed District Report" (HICKOK). The report noted that none of the city wells tested showed phenols greater than .005 mg/1 which was the limit of detectability for the choloform extraction method used.

In 1973 the City of St. Louis Park purchased the property with the agreement that they would hold the companies "harmless" from claims asserted against them by the PCA. But In January, 1974 the PCA informed the city that it had put a hold on the proposed stipulation for dismissal of the suit because recent tests by the MDH had shown the presence of phenols in the ground water.

Source: City of St. Louis Park Memorandums.

001610

MDH Report

In December of 1973, the MDH reported low levels of phenols in some municipal and several industrial wells near the site, and in September of 1974 they issued "Report on Investigation of Phenol Problem in Private and Municipal Wells in St. Louis Park, Minnesota". Following is a summary of this report.

The field investigation involved a well water testing program in which one sample per week was collected from each well for a 10 week period. Soil samples were also taken south of the Republic Creosote site. Phenol determinations were made using the MBTH (manual 3-methyl-2-benzothiazolininone) method.

Findings:

1. ≥ .002 mg/1 phenolic compounds were detected in both municipal and private wells; concentrations for individual wells varied over the sampling period.
2. wells showing the highest concentrations and the most consistent phenolic presence were located closest to the former Republic Creosote site.
3. Soil samples from bore hole #13 at a depth of 45 feet had a pronounced creosote odor and black viscous appearance.
4. The Flare Industries well showed continuous low level phenols; the Robinson Rubber Co. well showed continuous high level phenols; most wells had recurring patterns with an occassional high value. (Intermittant occurrence of phenols in wells may be related to the hydraulic influence of well pumping patterns.
5. Phenols were found in all of the aquifer formations down to 300 feet.

The report concluded that considering the huge amount of waste materials discharged to the surface, the length of time this activity took place, and the spatial arrangement of the affected wells, that it was possible that [illegible] contamination had taken place.

One of the recommendations that resulted from this investigation was implementation of an ongoing epidemiologic study of the possible public health hazards resulting from the pollution of affected aquifers.

001611

Average Phenolic Concentrations for some Municipal and Private Wells in St. Louis Park.

Well No.	Average Phenolic Concn (mg/l)
1	.0075
3	.0017
4	.0006
5	.0065
6	.001
8	.0074
9	.003
10	.003
11	.0037
12	.00275
13	.0023
14	.00055
15	.0009
MN. Rubber Company	.0022
S & K Prod.	.0011
Robinson Rubber	1.1
Burdick Grain	.0055
Flame Industries	.00355

001612

Source: [illegible]

Barr Phase I Study, Nov. 1975 - May 1976

In the Barr Phase I study 14 soil borings were analysed for phenols and benzene extractables to broadly indicate the presence of coal-tar derived wastes. The data indicated low levels in the top 10-15 feet over most of the site. The highest concentrations were found between Walker and Lake Streets (off the site). Here concentrations increased with depth, with high concentrations as deep as 50 feet.

Eleven soil samples were analyzed by TLC to qualitatively determine the presence of PAH compounds. Five samples were analyzed by GC to quantitatively measure the concentration of 6 PAH compounds. PAH were present in all 11 samples. High concentrations of PAH were detected at 32 feet and at 50 feet in soil columns south of the site between Hwy 7 and Lake Street. Detectable amounts of BaP and relatively large amounts of chrysene were indicated in 2 of the 5 samples.

Conclusions

1. The soluble fraction of coal-tar wastes (as measured by phenolics) has migrated southeast of the site.
2. The horizontal ground water movement in the surficial ground water system in the study area is generally to the southeast, and
3. The area of contamination is 2,200 feet by 1,000 feet, running in depth from the surface to the bedrock 70 feet below.

National Biocentric Report (hired by HUD)

In July of 1976 National Biocentric Inc. released a report entitled: "Proposal, Soil Boring and Chemical Analysis of the Northern Portion of Oak Park Village". Their goals were to locate bodies of contaminated soils and to determine depths of contaminant leaching. Soil samples were analyzed by GC/MS for PAH and pentachlorophenol. The PAH compounds analyzed included phenanthrene, pyrene, BaP, benzo (g,h,i) perylene, dibenz (a,h) anthracene, chrysene, and one chloronated aromatic hydrocarbon, carbazole. These were selected because of their relative abundance in creosote waste, their chromatographic elution time, and their carcinogenicity, mutagenicity and toxicity. Exploration was to 10 feet only.

Following this report the Housing Authority of St. Louis Park decided to push ahead with their plans for redevelopment of the northern portion of the Republic Creosote site despite the fact that the Barr Phase I Report cited evidence of contamination of the northern portion. They used as ammunition for their decision the fact that St. Louis Park slopes from north to south with the northerly parcels 10-15 feet higher than the southerly end, the fact that the northern portion of the site was used for storage of equipment only, and the finding from the Barr Phase I Report that ground water gradients appeared to be to the southeast.

Barr Phase II Report

The major emphases of Barr Phase II were to define the vertical and horizontal ground water flow through the various glacial and bedrock aquifers and to determine the chemical quality of the water in the various aquifers. Barr Engineering's interpretation of ground water movement in St. Louis Park follows.

Ground water movement in the upper drift aquifer is assumed to be primarily in the vertical direction as lateral flow to the east and west is restricted by the clay layers which nearly rise to the surface. Lateral flow in the middle drift aquifer is to the south and east. In addition there is substantial vertical recharge from the middle drift aquifer to the lower drift aquifer where lateral flow is assumed to be negligible, so that leakage from the middle drift aquifer to the lower drift aquifer must travel vertically to the underlying Platteville limestone.

Available data indicate that the flow in the Platteville limestone is to the east toward a buried bedrock valley which runs north - south beneath Wooddale Avenue. Because the flow is through fractures and fissures which have become solution channels it is difficult to predict its rate of movement.

The Platteville may be underlain by 3 feet of Glenwood shale (confining layer which is impermeable enough to maintain an 18 foot head difference between the Platteville and the underlying St. Peter. The flow in the St. Peter appears to be toward the east, but it is greatly influenced by the buried bedrock valley, and by certain wells. The buried valley in the southeastern portion of St. Louis Park cuts through the Glenwood, thereby connecting the glacial drift Platteville directly to the St. Peter, blocking the eastward flow in the St. Peter west of the buried valley, and allowing rapid recharge of the St. Peter.

Under existing conditions it is estimated that it would take 55 years for water to travel vertically from the St. Peter to the underlying Prairie du Chien-Jordan through the siltstones. A gradient to the east dominates the ground water flow in the Prairie du Chien-Jordan.

Barr Engineering hired SERCO Laboratories to do their water sample testing. The parameter used was phenolics, the method used was chloroform extraction, colorimetric, with a detection limit of .002 mg/1. (The reference for this method is APHA, AWWA, WPCF, 1976, Standard Methods for the Examination of Water and Wastewater, 14th Edition, page 576, APHA, 1015 18th Street NW, Washington D.C. 20036). Results follow.

Chemical analysis of surficial ground waters indicated that phenolic concentrations showed a high degree of variation from sample to sample. Barr contended that this may reflect a variation in the spatial distribution of phenolics in the ground water system, a difference in pumping rates and times prior to sample collection, or changing ground water quality.

Conclusions

1. The concentration of coal-tar derivatives throughout the soil column on the southern portion of the site and south of the site is much greater than on the northern half of the site.
2. The groundwater in the drift south and southeast of the site is moving laterally through outwash material and vertically into the Platteville. Groundwater movement through the Platteville is lateral probably towards the buried bedrock valley southeast of the site.
3. The ground water in the drift south and southeast of the site is contaminated. The movement of wastes has been lateral with the groundwater flow and vertical due to its higher specific gravity and due to vertical groundwater movement. The wastes contain phenolics and PAH's detected at 50 mg/l and 3,4[illegible] mg/1 respectively at a depth of 50 feet below the surface in the area [illegible] Hwy. 7 and Lake St. At the drift/Platteville contact PAH concentrations 1.7 mg/1 and phenolic concentrations of .3 mg/l have been measured.
4. The quality of the groundwater in the drift and Platteville aquifers is not at a steady state condition and the concentrations of coal-tar derivatives will likely continue to increase.

5. The buried bedrock valley southeast of the site is a recharge area to the St. Peter sandstone. From the buried valley, movement is likely to be eastward.

6. Available information is not sufficient to explain the reason for the phenolic concentrations is the St. Peter and Prairie du Chien-Jordan well field north of the site.

7. The coal-tar derivatives in the drift ground water system represent a potential threat to the underlying ground water aquifers due to: 1. uncased wells, 2. flow to the buried bedrock valley, 3. seepage through the Glenwood and 4. the abandonment of industrial wells that once acted as barriers to waste movement down-gradient of the contaminated groundwater, but now increase the potential for spread.

8. It is technically feasible to use a system of pump-out wells in the drift to control groundwater gradients and prevent the spread of coal-tar derivatives.

9. Use sanitary sewer and existing surface water treatment and disposal system as disposal routes for the effluent from the gradient control wells.

10. Excavation of contaminated soils is not an alternative to gradient control.

From these data some general conclusions were drawn by the MPCA:

1. Coal-tar wastes have moved from the surface downward due to water movement and the fact that they are heavier than water. High concentrations were found at a depth of 50 feet. The wastes have moved laterally at least 1,000 feet. This suggests that PAH compounds are present in water recharging the Platteville over a portion of study area.

2. Phenolic concentrations in the drift are moving southeast and at 30-50 feet per year. Water in the Platteville is moving to and the buried valley and will take 20-50 years to reach the valley.

3. The buried valley southeast of the site is a recharge area to the St. Peter. Movement out of the valley will likely be to the east.

4. Uncased wells provide pathways for contaminated water from the drift [illegible]

001617

Possible Mitigative Measures and Problems Therein

1. Treatment of the municipal water with activated carbon absorption would be very costly and not prevent the spread of contamination to wells in other areas.
2. Excavation of contaminated soils is not a complete solution since contaminants have moved in the groundwater out of the area of contaminated soils.
3. Problem - disposal of removed material; Hwy. 7 and several industries are situated above the area to be excavated.
4. Grout and abandon wells that are potential pathways for ground water to move between the drift/Platteville and the St. Peter and between the St. Peter and the Prairie du Chien-Jordan, etc.
5. Use gradient control wells to control the movement of contaminated groundwater such that the affected area does not increase. Wells would pump from the middle drift aquifer to limit both lateral flow in the drift and vertical recharge to the Platteville. To lower the phenol concentrations below 10 mg/l, the wells would have to be pumped 50-100 years.
6. Dispose of the contaminated groundwater from the gradient control wells by discharge to sanitary sewer and various treatment options prior to discharge to Minnehaha Creek.

In a letter to the MN PCA, the MN GS reported the possibility that the bedrock valley southeast of the creosote site was cut into the St. Peter sandstone and not just the Glenwood formation as postulated in Barr Phase II. Their findings indicated that Methodist Hospital overlys the [illegible] of a [illegible] valley cut into the St. Peter sandstone and that it extends at least as [illegible] north toward the former creosote site as the extension of Louisiana Avenue over the Chicago Milwaukee, St. Paul and Pacific railroad tracks. [illegible] suggested that a second valley underlying [illegible] Avenue [illegible]

St. Peter sandstone and that these buried valleys southeast and east of the site would create a much larger recharge area for the St. Peter than depicted in the Barr Report.

Furthermore, the MN GS questioned the hydrologic modeling and ground water gradient recommended by the Barr Report as well as their assumptions used to predict contamination migration. Barr postulated that the contaminants and the ground water moved as a single phase flow, but MN GS cautioned that the contaminants could be moving at different velocities and directions than the ground water or that they could be trapped creating stagnant pockets. Therefore the MN GS suggested that information regarding the mobility of the contaminants be presented before initiating a gradient control system.

MDH Health Risk Report I

In October of 1977 the MDH released a report entitled "Assessment of Possible Human Health Effects Resulting from the Contamination of the Former Republic Creosote Site". In this assessment they dealt with the contamination of the drinking water supplies of St. Louis Park and Edina only, which had been shown to contain trace quantities of phenols, a major constituent of creosote.

They estimated the maximum acceptable benzpyrene concentration in drinking water and the existing concentrations of benzpyrene in the water supplies of St. Louis Park and Edina. They then evaluated the significance of the difference between the 2 values and found that the estimated exposure was about 1,000 times higher than the maximum acceptable exposure which was estimated to be very low, 3.1×10^{-4} ug/l. These findings suggested to them the existence of a potentially serious public health problem.

Some of the recommendations included in the report were:

1. Determine the possible source of coal-tar taste in old city well #1 which extends into the St. Lawrence shale and is cased to the top 60 feet of the Shakopee limestone. This "taste" could indicate that the Prairie du Chien-Jordan is seriously contaminated in the study area.
2. Examine the buried bedrock valley to the east of the site to determine the presence or absense of a high permeability "pipeline" at the bottom of the valley which could provide a rapid travel path for contaminated ground water.
3. Conduct solubility studies to determine to what extent constituents of coal-tar wastes are soluble in groundwater under environmental conditions (necessary to predict future concentration and movement through the under-ground).
4. The source of the high concentrations of phenols in the Robinson [illegible] Company well should be determined (which aquifer).

001620

One of the recommendations they made was for the design and implementation of a pumpout and barrier well system capable of removing and halting the spread of contaminated water in the drift and lower aquifers. Barr Phase II had recommended that the effluent from the barrier well system be discharged into the sewer. MDH stated that the wastes must receive extensive treatment before discharge to the sewer because the literature indicated that conventional sewage treatment would not be effective in removing BP and other PAH compounds.

Serco Report, August 3, 1978

From June 27 - July 7, 1978 Serco Laboratories in Roseville took water samples from all 14 municipal wells in the City of St. Louis Park and also from wells in 5 suburbs surrounding the city. (Plymouth, Robbinsdale, Minnetonka, Hopkins and Edina). The MDH collected a duplicate sample.

The purpose of this well water survey was to determine if detectable levels of phenols existed in the St. Louis Park water supply. The analytical procedure used by both laboratories for the determination of phenols was the 3-methyl-2-benzothiazolininone (MBTH) colorimetric procedure, as adopted for use by the MDH from work by Friestad (1969).

Results:

1. All of the phenol concentrations were at very low levels.
2. All phenol determinations by Serco for the St. Louis Park wells were at or below the detection limit of .002 mg/1. The MDH results were somewhat higher.
3. Results indicated no significant difference between St. Louis Park water and water sampled from the surrounding communities.

001622

MDH Health Risk Report 2

In November of 1978 the MDH issued a report entitled "Health Implications of Polynuclear Aromatic Hydrocarbons in St. Louis Park Drinking Water". This report was an assessment of the first phase of a study of the municipal wells in the area to determine the concentrations of specific polynuclear aromatic hydrocarbons in the drinking water.

From May 8 - August 9, 1978 samples were taken from municipal drinking water wells in St. Louis Park, Edina, Robbinsdale, White Bear Lake, and Fridley. Samples of Minneapolis and St. Paul drinking water were collected November 8, 1978. The results are contained in Table 1 borrowed from the Report.

The MDH selected St. Louis Park, Edina and Robbinsdale for the study because they use ground water for drinking, they are geographically near the former Republic Creosote site, and each had had positive phenols detected in the past. Fridley and White Bear Lake were selected as controls because they use ground water for drinking, but are to the north and east, and on the other side of the Mississippi River, from the former creosote site and thus presumably "safe" from contamination. Minneapolis and St. Paul were selected to determine PAH exposure from a surface water supply. Samples were not taken from Plymouth, Minnetonka or Hopkins because the Barr Report had showed the general direction of ground water flow to be to the east (results indicate that this may be in error).

Water samples were analyzed by high performance liquid chromatography (HPLC) using a modification of a method developed by the U.S. EPA (picks up fluorescing PAH). Positive results were obtained for pyrene, fluoranthene, anthracene, and naphthacene. Identification of these compounds was confirmed by gas chromatography/mass spectrometry. The values expressed as "less than" are below the detection limit.

In order of decreasing contamination, St. Louis Park wells [illegible] & 14 were the most heavily contaminated. These wells are all in the Prairie du Chien-Jordan aquifer.

001623

(Note: the least contaminated of the 5 is furthest from the creosote waste disposal area at 1.73 miles)

Samples from the Edina, Robbinsdale, White Bear Lake, Fridley, Minneapolis and St. Paul water supplies were all negative.

The geographical distribution of positive values indicated to the MDH that the contamination was flowing northward, reflecting the complexity of the ground water flow patterns in the area (ground water generally flows to the east in the Prairie du Chien-Jordan aquifer).

The MDH stated that the task of risk assessment is a difficult one because there are no epidemiologic studies on exposure to PAH compounds via ingestion and because the PAH compounds detected in the St. Louis Park water supply are cocarcinogens. the health effects of which would be partially dependent on interaction with other compounds. Futhermore, the only drinking water standards for PAH compounds are the guidelines set by the WHO and the CEC which state that whenever the sum of the concentrations of six specific PAH compounds exceeds 200 nanograms/liter, the water should not be used for human consumption. Fluoranthene is one of these six compounds, and in St. Louis Park wells 10 & 15 it averaged 321 nanograms/liter.

The risk assessment the MDH did in this report involved a comparison of a drinking water exposure with <u>all other</u> ingested exposures to pyrene, fluoranthene anthracene with the conclusion that potential risk exists.

One of the recommendations the report made was that the St. Louis Park water supply be periodically sampled for PAH compounds at a number of locations in the distribution system to determine the effects of dilution with water from uncontaminated wells, the magnitude of any seasonal variations in PAH concentrations, and the actual population dose distribution.

(On November 14, 1978 a news release from the MDH announced the closing of St. Louis Park wells 10, 15, 7 and 9. St. Louis Park stopped using these contaminated wells November 10.)

001624

Below is data for the contaminated wells only, taken from Table 1 of the MDH Report.

PAH in Drinking Water*

(nanograms/liter)

SLP well #	Depth	Aquifer	A	P	Fl	BaP	BghiPE	cPP	[illegible]
7	446	PdC-J	11.4	104	7.4	<1.1	<4.4	<1.1	<10
9	473	PdC-J	12.2	199	21.1	<1.1	<4.4	<1.1	<10
10	500	PdC-J	100	800	450	<1.1	<9.8	<2.1	-
10	500	PdC-J	54	486	152	1.3	4.4	<1.2	80
14	485	PdC-J	6.3	<47	4.2	1.8	5.5	2.2	<10
14	485	PdC-J	6.3	<47	2.4	<1.2	5.4	<1.1	<10
15	503	PdC-J	190	750	390	<1.2	<10.7	<2.4	-
15	503	PdC-J	241	1221	292	1.5	6.8	2.0	160

* < = less than detection limit

A = anthracene

P = pyrene

Fl = fluoranthene

BaP = benzo [a] pyrene

BghiPE = benzo [ghi] perylene

iPP = o - phenylenepyrene

PdC-J = Praire du Chien-Jordan aquifer

RFP - MAY, 1978

Some figures and comments from the Request for Proposal written by the MDH include:

1. Excavation of contaminated soils could be expected to cost between 20 and 100 million dollars.
2. Treatment of all municipal water could be expected to cost up to $100 million per year if the source of contamination is not removed.
3. The hydrogeology of the study area is extremely complex and to determine the most effective and efficient method of contamination removal it must be better understood.
4. The original time limit of 18 months has been extended because the legislature appropriated only one-half of the money requested.

The Phase I Study requested involved a study of the hydrology and geology of the buried bedrock valleys, the construction and operation of wells to analyze and monitor water quality in the St. Peter aquifer, the investigation of the source of coal-tar taste in old city well # 1, and programs of well abandonment.

The Phase II Study requested involved the development of a 3 - dimensional diffusion dispersion model designed to predict the effectiveness of a barrier well system for controlling and removing contaminated water.

The statement of work was for a preliminary report due December 30, 1978 (delayed, was submitted in February of 1979) and a final report submitted June 30, 1979 (delayed, should be ready by October, 1979). The USGS was contracted to do the above work.

001426

USGS Preliminary Report

In February of 1979 the US Geological Survey submitted a preliminary report of their activities to the MDH.

In this report they summarized the current information available on the location and construction of wells which may contribute to the spread of contaminants between aquifers for the purpose of possible reconstruction or abandonment of these wells. (Only 2 municipal wells were considered, St. Louis Park old city well # 1 and St. Louis Park well # 3).

Initial data on wells was obtained from the USGS, the MN GS, The St. Louis Park Department of Public Works files and the Sunde (1974) and the Barr (1977) reports. They also interviewed area residents, local business employees and drillers.

When possible, water levels and depths of wells were measured and wells were geophysically logged to verify well construction, stratigraphy, and to get a measure of possible vertical flow. The majority of private and industrial wells located, however, contained obstructions such as pumps, liners or debris which prevented logging and inspection by a downhole television camera.

The greatest priority for investigation was given to the area immediately surrounding the former creosote site. A second area of investigation was to be Golden Valley to the north, Minneapolis to the east, Edina to the south, and Hopkins and Minnetonka to the west .

USGS stated that the uncased or ungrouted wells which penetrate more than one aquifer (multiaquifer wells) are of particular concern because they provide avenues for the transport of contaminants as they tend to be unstable and any casing originally there deteriorates with time. They used the Hinckley well on the former creosote site as an example. It was originally constructed to permit the flow of water out of the Prairie du Chien-Jordan aquifer and into the underlying Ironton-Galesville and Mt. Simon-Hinckley aquifer from the overlying St. Peter aquifer as well. This is a result of a leak in the casing adjacent to the St. Peter sandstone. Water that is entering the well bore through this leak is flowing downward at a rate of approximately 100 gpm.

The USGS found the Hinckley well to be visibly contaminated, as a result of a spill that occurred directly into the well. Thus the Hinckley well is not only a pathway of contamination but also a source of contamination. Following are factors which contribute to the complexity of the geohydrology of the bedrock system as elucidated by the USGS:

1. The large number of pumping wells in the area, many of which are multi-aquifer wells which have the effect of changing the direction of ground water flow. A cone of depression is created in the aquifer with the higher head by withdrawal of water from it; conversely injection of water into a lower aquifer creates a cone of impression. A cone of impression caused at least in part by the "Hinckley" well occurs in the Prairie du Chien-Jordan aquifer. Data indicate that water in this aquifer is moving away from the well in all directions, but the steepest gradient is found between the "Hinckley" well and the municipal well field to the north. This gradient descreased after closing St. Louis Park wells 7, 9, 10 and 15. (These facts support the conclusion by the MDH that previous studies indicating that water can't move from the site to the well fields to the north through the Prairie du Chien-Jordan aquifer may be in error).
2. Many wells are pumped only on a seasonal basis.
3. Uncased wells provide pathways for ground water movement from high to lower potentials.
4. Buried bedrock valleys provide natural pathways for contaminant transport.

Appendix F. Literature Review of Polynuclear Aromatic Hydrocarbons (PAH) in Water.

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